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LUMBAR MYELOGRAPHY BY ABRODIL[1]

by

Knut Lindblom

In 1944 ARNELL reported his further experiences of a method of myelography, originally described by ARNELL and LIDSTRÖM in 1931. As contrast medium they used abrodil or skiodan in 20 per cent solution. The irritation from the abrodil was eliminated by lumbar anaesthesia, and in ARNELL's report of 70 cases he had no other complications than a few cases of headache, caused by the anaesthesia. The abrodil gave excellent pictures of the lumbal portion of the dural sac with the nerve-roots, and was quickly absorbed. He made the exposures with vertical direction of rays, and the patient in prone and supine positions.

The method of ARNELL was used by FELTSTRÖM in 20 cases and by NORDENTOFT in 8 cases. NORDENTOFT had 1 case of cramp, but this happened in his sole case without lumbar anaesthesia. No other complications were mentioned.

Since May 1944 the abrodil is used at Karolinska sjukhuset for lumbar myelography. The technique is altered in order to give still more details of passages of the roots through the dura. The result is that the examination by abrodil has replaced the myelography by gas as to the diagnosis of disk prolapses in the lumbar region.

Technique

The patient is placed on the diseased side with the waist pillowed in order to straighten the back. The cranial end of the table is raised about twenty centimetres. A low lumbar puncture is made and a lumbar anaesthesia is given. One cc of ephedrin is injected subcutaneously in

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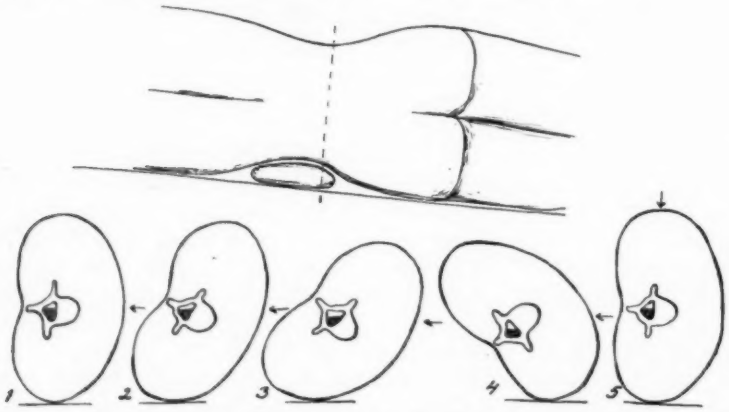
order to prevent a fall of the blood pressure. The blood pressure is observed during the rest of the examination. After a few minutes the lumbar needle is opened again, and 10 cc of 20 per cent abrodil are injected slowly. The diameter of the needle should be small. Otherwise there is a leakage of contrast to the epidural space.

Four exposures are made in a horizontal direction of rays and two in a vertical direction. During the four horizontal exposures the patient has the following positions: lateral, a little ventro-lateral, more ventro-lateral, and dorso-lateral (Figs. 1—4). During the two vertical exposures the patient is in a lateral position (Fig. 5); one exposure refers to the lumbar portion and the other to the lumbo-sacral part.



Figs. 1—5. Sketches of the positioning of the patient and the sedimentation of the abrodil. Arrows mark the direction of rays.

The technique described was used in all cases with exception of the first four cases which were examined according to ARNELL. The fifth case was examined in both ways, and this case illustrated the advantage of the new technique. The small muffetees of the dural space around the roots lateral to the dural sac appeared far more distinct by the new technique. In the lumbar liquor the abrodil forms a sediment, most concentrated at the bottom which in a lateral position means the lateral wall.

The technique described does not exclude an examination of both sides without reinjection. If wanted the patient is warily turned over to his other side, and the examination is repeated. Since the normal anatomy of the both sides must not coincide in all cases, a comparison has little value.

Complications

The third and the fourth cases complained of a slight tendency to spasm in the legs 2—4 hours after the examination. In the following 47 cases the examination was followed by a new lumbar puncture. In this way about one half of the abrodil was drained and the patients had no spasms. Later on 34 cases were examined without tap of abrodil and no spasms were reported.

A few patients had back pains during injection of the abrodil, but after a little while the pains disappeared.

Three patients had headache for some days. This complication may be explained by the lumbar puncture and the anaesthesia.[1]

Material

The material consists of 75 cases examined on account of low back and irradiating pains of sciatic type. The duration of the symptoms varied from 2 weeks to 15 years.

The myelograms were pathological in 56 cases and normal in 15 cases. In 1 case the examination was incomplete, and in 3 cases the findings were questionable. In the pathologic series 40 cases had displacements of two or more roots from a distinct bulge of a disk, while the remaining 16 cases showed a bulging of disks without signs of compression of roots. Two cases had a bulge from the region of the intervertebral joints also.

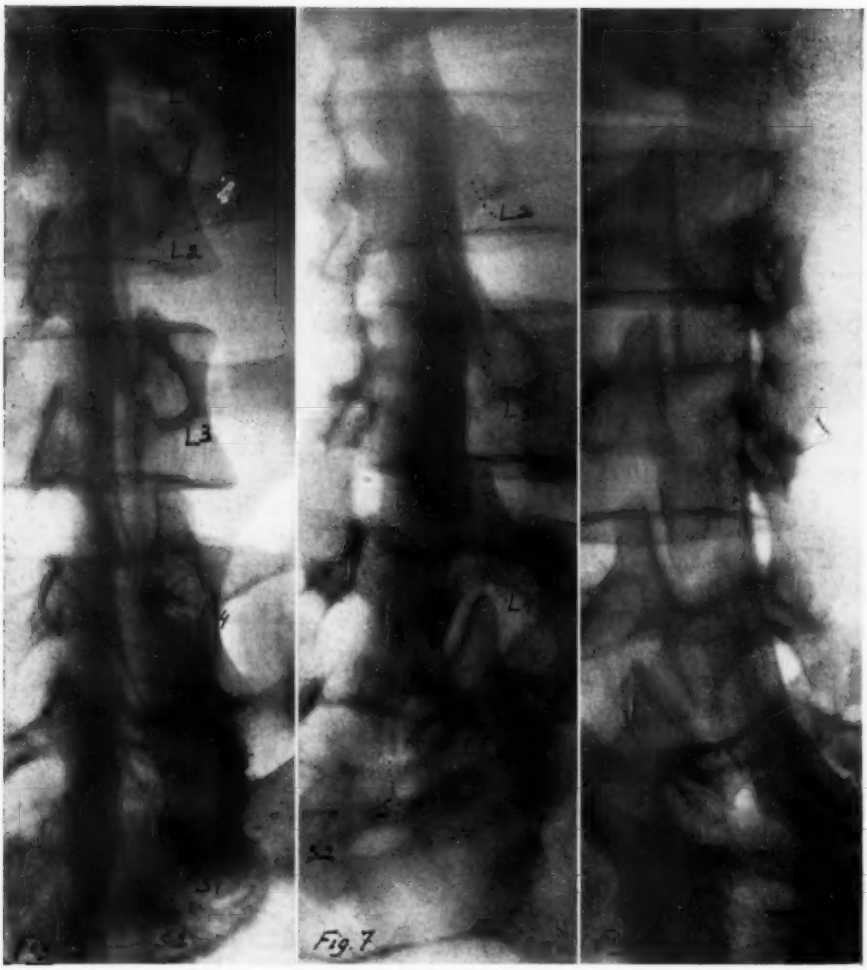
Operations were performed in 30 cases. In 25 cases a disk prolapse was found, either naked or covered by a bulging annulus. In 4 cases the findings were bulging disks, out of which no or small masses were emptied through incisions. In the remaining case an inexperienced operator was not able to see anything pathological.

With one exception the operated cases all belonged to the group of compressed roots in the myelogram. In the remaining case the roentgen examination was interrupted by a serious fall of the blood pressure on account of missing prophylaxis by ephedrin. No lateral view was taken and a large prolapse in the midline was overlooked. This case illustrates the value of the lateral view in cases of median prolapses.

The only case of real disagreement between myelography and operation is mentioned above. The myelographic findings of an indisputable bulge of a disk with impression in the dural sac were not verified at the operation.

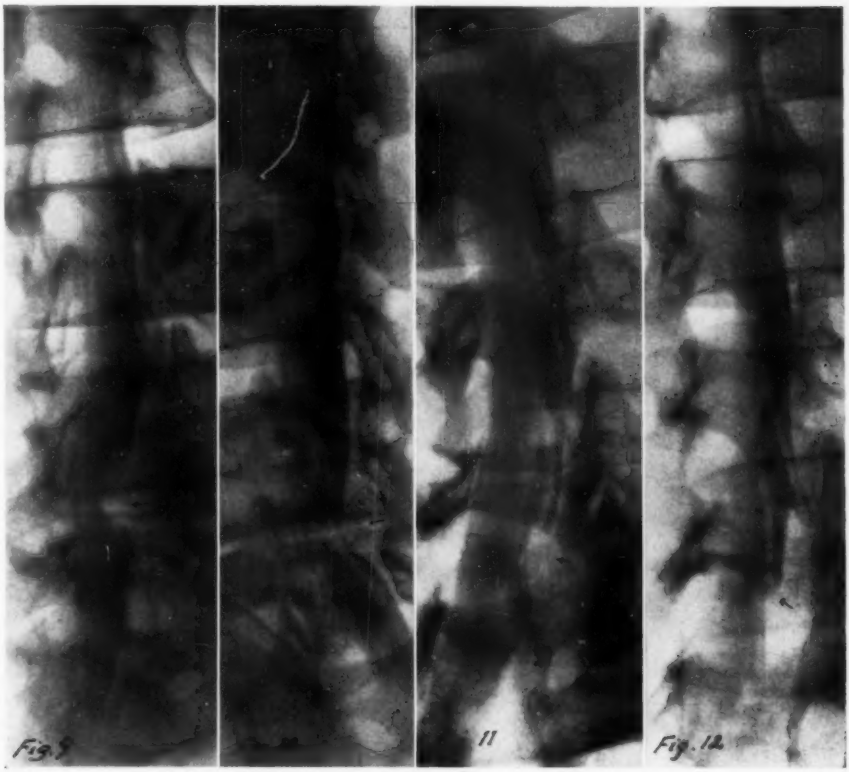
Besides these 30 cases still another case was operated upon though before the myelography by abrodil. Neither the inspection nor the myelography showed any protrusion of disks into the spinal canal.

[1] The risks of complications will be discussed in detail in another paper.



Figs. 6—8. Myelograms corresponding to the positions in Figs. 1, 3, and 4. No compression of the dural sac.

At operation the level of the lesion was L 3—4 in 1 case, L 4—5 in 16 cases and L 5—S 1 in 12 cases. By myelography the level was right determined in all cases but two. In one case the myelograms were wrong interpreted. In the other case the disk prolapse in the midline was located on the posterior surface of the fifth lumbar vertebra, and the



Figs. 9—10. Myelograms; big prolapse L 4—5 with nerve compression. In Fig. 10 compression from behind also, though the ligamentum flavum appeared normal at operation.

Figs. 11—12. Myelograms of two cases of disk prolapses with moderate and slight compressions of nerves. In Fig. 12 questionable findings on myelography: defect of the root sleeve, and widening of the root end.

roentgenograms did not tell whether it came from the disk above or below the vertebra. The operation showed its origin in the superior disk. In an anatomical study of the disk protrusions the author found such caudal dislocations, and the base for it was a tendency to inferior situation of the medial-posterior ruptures in lower lumbar region.

In order to illustrate the great value of the level diagnostics by myelography the neurologic signs of the operated cases will be summarized. »Thigh lat.», »foot med.» etc. mean the dermatomes of the

Figs. 13—14. Myelograms of a case of median disk prolapse illustrating the value of the lateral view (Fig. 14).

Fig. 15. Myelogram of a case of a prolapse originating from the fourth disk and descended to the posterior surface of the fifth vertebra.

Fig. 16. Myelogram showing displaced nerves; at operation a moderate bulging of the disk and no prolapse visible directly or obtainable by incision of the disk.

pains. »Great toe paresis» means paresis of the dorsal flexors of the great toe. »Pat. jerk» and »ankle jerk» mean decreased or abolished patellar and ankle jerks. The figures mean number of cases.

L 3—4 (1 case): Thigh lat., lower leg ant., pat. jerk.

L 4—5 (16 cases): Gluteal region — thigh 1, leg 1, lower leg 1, calf lat. 3, planta 1, foot med. 3, foot lat. 6, great toe paresis 3, pat. jerk 2, ankle jerk 3, pat. and ankle jerk 2, ankle jerk increased 1.

L 5—S 1 (12 cases): Gluteal region — thigh post. 1, lower leg 3, calf 2, foot med. 1, foot lat. 5, ankle jerk 9, pat. and ankle jerk 2.

The explorations of the disks was directed by the myelograms and therefore no full equity was made as to the clinical symptoms. The presence of prolapses from other disks cannot be excluded as they were not inspected by operation. Yet, the review of the neurologic signs indicates the difficulties of the diagnosis without myelography.

On the whole the clinical symptoms had the same quality in visible prolapses as in diffuse bulgings of disks or normal myelographies. A satisfactory explanation of the symptoms in the cases of normal myelographies give the disk protrusions and nerve compressions at the lateral side of the intervertebral foramina, known from the anatomical studies.

SUMMARY

Experiences of myelography by abrodil are reported. A modification of ARNELL's method was used. The myelographies were made on sciatic cases in order to study lumbar prolapses of disks. The method was harmless, and the myelographic and operative findings showed a good agreement.

ZUSAMMENFASSUNG

Verf. berichtet über Erfahrungen bei Myelographie mit Abrodil nach einer Modifikation der ARNELL'schen Methode. Es handelte sich bei den Myelographien um Fälle von Ischias, und zwar sollte ein lumbaler Zwischenwirbelscheibenprolaps nachgewiesen werden. Die Methode war ungefährlich, und es lag gute Übereinstimmung zwischen den myelographischen und operativen Befunden vor.

RÉSUMÉ

L'auteur expose des expériences de myélographie à l'abrodil suivant la méthode d'ARNELL modifiée. Les myélographies devaient servir à démontrer des hernies de disques intervértébraux dans des cas de sciatique. La méthode est sans danger et les images myélographiques ont été confirmées par vérifications opératoires.

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THE ROENTGENOLOGICAL PICTURE OF THE COARCTATION OF AORTA AND ITS ANATOMICAL BASIS[1]

by

H. Gladnikoff

Operative treatment (CRAFOORD) has given quite a different value to the diagnosis of the coarctation of aortae and its roentgenological picture. In 3 cases so far treated normal circulation was again established by operations, resection of the coarctated part of the aortae and then suturing of the aorta. By this means more or less severe disablement as well as considerable risk for premature death (HAMILTON & ABBOTT) has been eliminated.

In 1789 a *pathological-anatomical* description was given by PARIS, Prosector of the Hôtel Dieu in Paris, of a case of coarctation in the upper part of the descending aorta of an adult with characteristic collaterals. Adult coarctation in this form (fig. 1) develops gradually after birth (BONNET), so that collaterals have time to grow with more or less sufficient circulation even in the trunk and the lower extremities.

It will seem as though hereditary factors must be included in the *etiology* (KLEMOLA): out of four cases nos. 1 and 2 were brothers, as well as nos. 3 and 4.

The *frequency* of the disease is said to vary considerably. Out of 10,000 autopsies carried out at the Sabbatsberg Hospital 3 cases have been met with (Å. LINDGREN), which could correspond to 1,500 cases among the Swedish population of 6 million.

Clinically the picture is dominated by a praestenotic increase in blood pressure, a decrease in blood pressure in the blood-vessel region for the rest and by the collaterals between these blood-vessel regions. There may, however, be no increase in the blood pressure in parts of the praestenotic blood-vessel region, for instance an arm (KING), which

[1] Submitted for publication, June 12, 1945.

has in some cases been proved to be due to local changes in the vessels (East, Love & Holms).

The *prognosis* (Hamilton & Abbott) varies considerably in each particular case. There may be a total lack of subjective symptoms, which does not necessarily imply a better prognosis but may end in sudden death. The causes of death are congestive heart failure, rupture of aorta, cerebral haemorrhage, bacterial endarteritis and sudden heart rupture.

The *treatment* has so far been only symptomatic.

Roentgenographically changes in the ribs, the heart and the different parts of the aorta thoracalis, the superior mediastinum and the oesophagus have been described.

The *changes in the ribs* (Railsback & Dock, Fray) consist in a widening of the sulci costales and long or punched-like defects bilaterally on the lower edges of the ribs (fig. 2). They are caused by the intercostal arteries (fig. 1), which form a considerable part of the collaterals and which have been dilated and elongated and consequently twisted. The changes on the ribs do not exist in every case. They have been looked upon as pathognomonic but the same changes have also occasionally been observed (Laubry & Heim de Balsac) in disease of the aortic and mitral valves and essential hypertension.

Fig. 1. From Love & Holms, Am. Heart Journ. 17, p. 620, 1939. Stenosis at the insertion of the ligament of Botalli, in this case immediately under the origin of the left subclavian artery. Collateral circulation between the subclavian arteries and the descending aorta through the intercostal arteries. Extreme tortuosity of these, resulting in erosions on the ribs.

The *heart* is hypertonic and consequently in 3/4 of the cases there is hypertrophy of the left ventricle (Fray) as well as an increase in the amplitude of its pulsations.

The *ascending aorta* is widened (Fray, Kerley, Schatzki & Hallermann), while curiously enough the shadow of the aortic knuckle is absent (Assman, Schatzki & Hallermann, Kerley) or very small. The widening of the ascending aorta is, however, not constant.

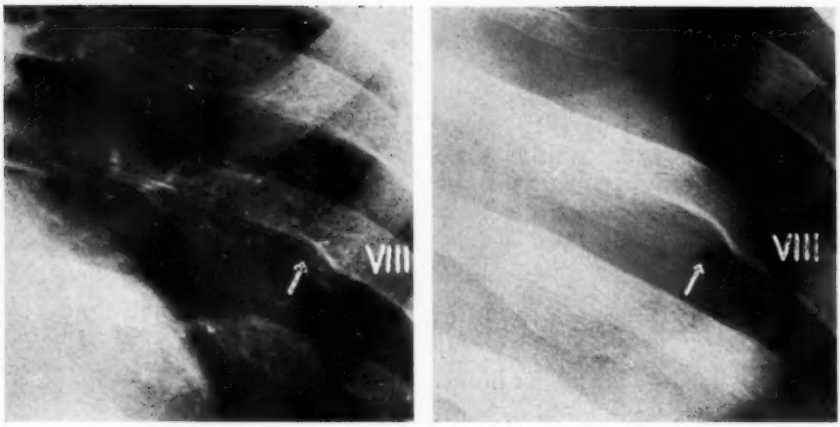


Fig. 2 a. Fig. 2 b.

Case 2. Ribs: Costal sulci widened in several places. Bone so thin here that structure cannot be observed on radiograms made with hard roentgen rays (fig. 2 a), but appears when rays of a soft quality and a suitable secondary diaphragm are used (fig. 2 b).

The *aortic arch* is difficult and often impossible to outline (FRAY, KERLEY, RAILSBACK & DOCK, SCHATZKI & HALLERMANN, WOLKE) and the possibility to observe the descending aorta is reduced. This is surprising (KERLEY) considering the sometimes extreme hypertension. The invisibility of the arch should be due to defect or discontinuity (FRAY) of the arch.

The widened shadow of the *superior mediastinum* is strongly pulsating and is hence caused by arteries (ASSMAN, SCHATZKI & HALLERMAN, KLEMOLA).

The widening may be far stronger than in hypertension and sclerosis of the aorta. The outline to the left of the superior mediastinum is often convex (fig. 4, 5, 6, 7 and 8). Earlier writers have interpreted this convexity as the aortic knot.

The shadow of the *posterior mediastinum* shows to the left approximately on a level with the fifth vertebra an indentation (fig. 5, 6, 7 and 8) of barely one centimeter in depth (WOLKE).

Oesophagus sometimes shows a bulge in its left outline on a level with the indentation. The indentation as well as this bulge would directly indicate the coarctated part on the aorta (WOLKE).

The roentgenographic picture of this disease has not been made clear by earlier writers in the following respects: What is the anatomical basis for

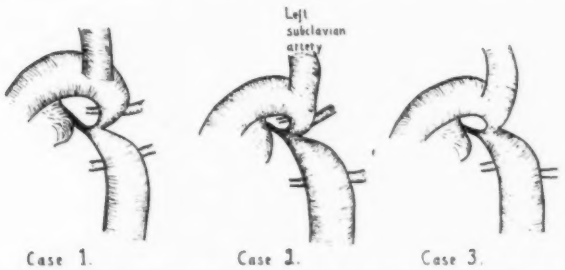


Fig. 3. Operation findings: In all three cases the stenosis was found to be situated at the insertion of the ligament of Botalli, from which place aorta expanded conically in both directions. The ligament of Botalli was shortened to a length of 4—5 mm, and consequently the adjacent *parts of aorta had been drawn medially* and ventrally in *towards mediastinum, so that an extra V-shaped curve had developed* on aorta.

In case 1 the stenosis was situated about 5 cm below the origin of the *left subclavian artery*, in case 2 this distance was considerably less, while in case 3 the stenosis was situated exactly at the origin of the artery. In all three cases this artery *was distended and its lateral outline met the lateral outline of aorta in an obtuse angle with its tip directed towards mediastinum*. The lateral outlines of the actual stenoses in all three cases on the other hand were bridged over by pleura and subpleural tissue. Dorsally it is true that the stenosis was only partially bridged over by these tissues, but the indentation in the outline of posterior mediastinum caused by the stenosis was much smaller than that between the left subclavian artery and aorta.

When inspecting and palpating the pulsations were found to be strong in the praestenotic part of aorta, while below the stenosis they were very slack and the pressure extremely low.

After resecting the most severely coarctated part and suturing aorta the pulsations became normal in the whole of the descending aorta.

In case 2 the minor azygos vein and the accessory minor azygos vein were wide and prominent from mediastinum parallel with aorta.

1. the left outline of the superior mediastinum?
2. the indentation in the posterior mediastinum?
3. the reduced possibility for observing the »aortic knot», the aortic arch and the descending aorta?
4. the bulge in the left outline of oesophagus?

The writer considers that the three following cases illustrate these points, especially the operation findings.

Two of the same cases are more completely described from surgical and medical standpoint by CRAFOORD & NYLIN.

Case 1. K I 2010/1944. Patient is a boy of 11. Increasing fatigue since 1940. Blood pressure in 1942 was 190 mm, after which time it remained at about 150 mm.

Status 26/9 1944. Weak physique, pale boy in a generally good state of health. Lungs, abdomen etc. as well as reflexes normal.

Circulation: No oedema, no cyanosis. Moderate dyspnea after sligt exertion.

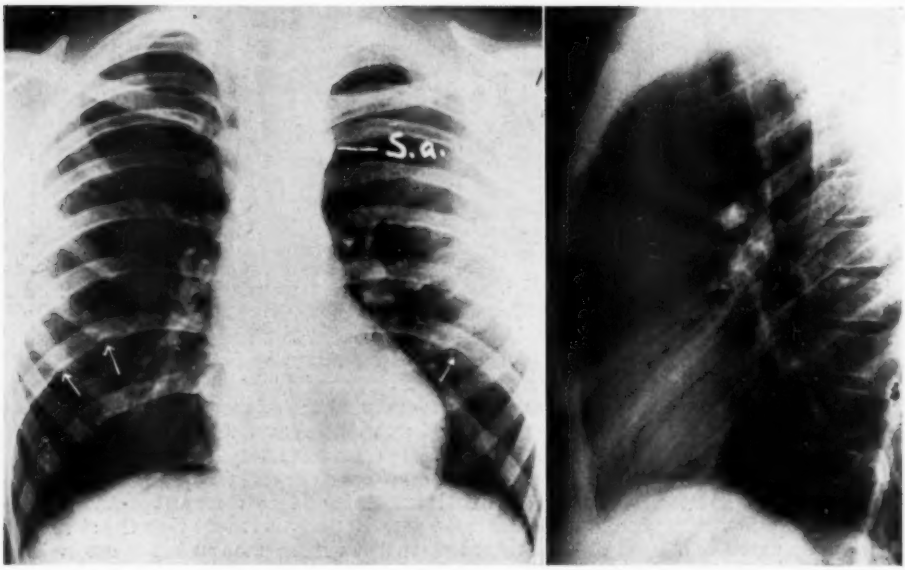


Fig. 4. Case 1. Superior mediastinum widened with convex outline to the left of dilated left subclavian artery (S. a.), easily mistaken for aortic knot. Ascending aorta not widened. Aortic knot cannot be demarcated, nor can aortic arch or descending aorta in lateral projection. Rib defects. Cardiac volume before operation 450 ml, cardiac volume/m_2 body surface 380 ml. Cardiac volume four months after operation 375 ml, cardiac volume/m_2 body surface 320 ml.

Heart: The apex beat was within the left midclavicular line. There was a loud systolic murmur, loudest in the second intercostal space to the left.

Blood-pressure: In arms 170/105, in legs 100/70 mm Hg.

Pulsations were not palpable in the legs nor in the popliteal area.

Collaterals: Fairly large, strongly pulsating tortuous arteries palpated in the upper part of the front of the thorax.

For *roentgen examination* see fig. 4.

Oscillography with the EJRUP equipment: Before operation high blood-pressure and good oscillations were found in the arms. In the legs the blood-pressure was low and the pulsations very small. After operation the blood-pressure decreased in the arms and increased in the legs.

Work-tonooscillography ad modum EJRUP: Before operation distinct increase in blood-pressure in the arms after hard work but neither increase of the blood-pressure nor of the pulsation of the legs. (This examination has not yet been carried out subsequent to operation.)

Operation 19/10 1944 (CRAFOORD): See fig. 3.

When examined 4 months after the operation the patient was subjectively free from trouble and had begun school again. Blood-pressure in the left arm was 130/80 mm Hg, in left leg 150/80 mm Hg.

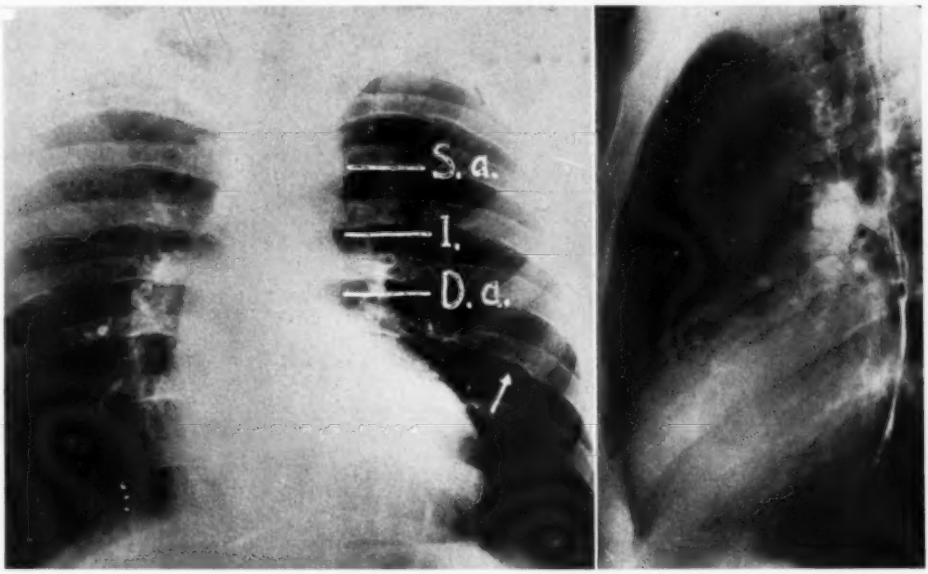


Fig. 5 a. Fig. 5 b.

Fig. 5. Case 2. Enlargment of heart, most strongly pronounced in left ventricle and auricle. Cardiac volume before operation 1,120 ml, cardiac volume/m_2 body surface 620 ml. 4 months after operation resp. 880 and 465 ml. Ascending aorta shows an increased curve, and like the left ventricle increased amplitude in pulsations. Aortic knot is not visible, nor is aortic arch in side picture. Left subclavian artery (S. a.) easily mistaken for aortic knot on account of shortened aorta. Descending aorta (D. a.). Indentation (I.) between subclavian artery and aorta. Rib defects.

Case 2. K I 1894/1944. The patient is a farm labourer of 27, who has always had heavy work and has managed to carry it out without any difficulty.

For the past two years the patient has been troubled with a heaviness in the head, giddiness, fatigue, shortness of breath when going up hill and a feeling of pressure in the region of the heart. He feels tired and weak in the legs.

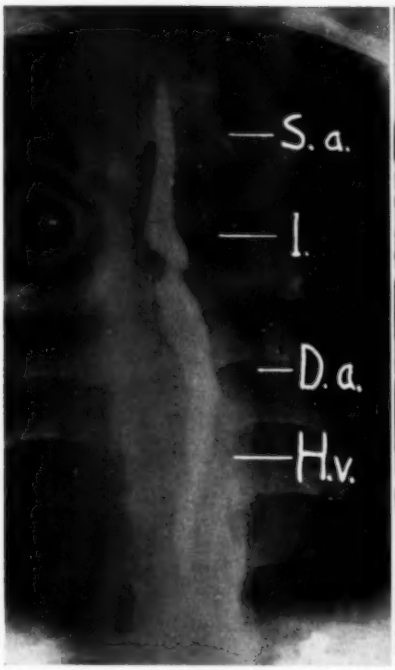
Status 2/10 -44. Strongly built with ruddy complexion. No oedema. General condition good. Lungs, abdomen and reflexes etc., nothing to comment on.

Heart: The heart is enlarged. There is a systolic murmur over the whole precordium, and it is loudest in the second intercostal space close to sternum, where the 2nd tone is strongly accentuated as well as over the apex.

Collaterals in the form of enlarged arteries are palpable in the thoracic wall.

Blood pressure: Right arm 180/100, left arm 175/100 mm Hg. Right and left legs under 100 mm Hg. The determination was carried out by oscillography, no pulsations being palpable or audible.

Work-tonoscillography according to EJRUP: There is a considerable increase of the blood-pressure in the arms, but no change of blood-pressure or pulsations in the legs. After operation the increase in the blood-pressure in the legs becomes normal.



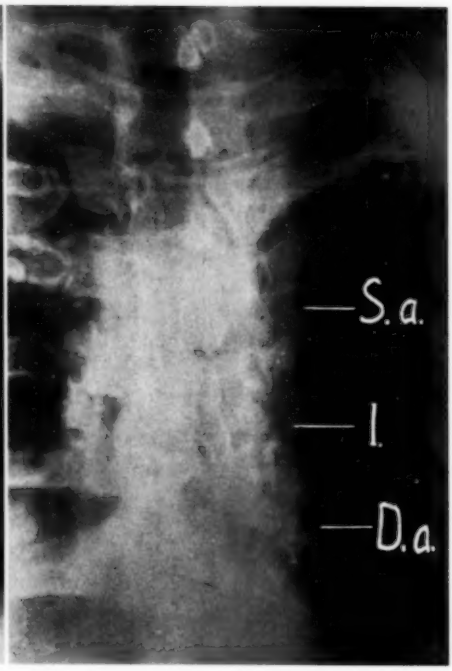


Fig. 6. Fig. 7.

Fig. 6. Case 2. Superior mediastinum widened, left outline formed of dilated, left subclavian artery (S. a.). Indentation (I.) in posterior mediastinum where left subclavian artery leaves aorta. Aortic knuckle invisible, aorta shortened. Medially of outline of descending aorta (D. a.) the coarse hemiazygos vein (H. v.) produces outline. Oesophagus shows a fairly strong impression of left principle bronchus and a probably increased impression from the right of the left auricle. There is no bulge beyond this corresponding to the position of coarctation of aorta.

Fig. 7. Case 2. Superior mediastinum with left subclavian artery (S. a.), descending aorta (D. a.) and the indentation (I.) between left subclavian artery and descendning aorta.

Function test on the heart shows insufficiency when doing heavy work, though there is none when the patient works just moderately.

Roentgen examination see fig. 2, 5, 6, 7.

Operation 31/10 -44 (CRAFOORD): See fig. 3.

Four months after the operation the patient had begun work and felt nothing of his former discomfort.

Case 3. K I 428/1945. The patient is a woman of 19, who has been suffering from hypertension for 2 years. During the last year she has been troubled with increasing

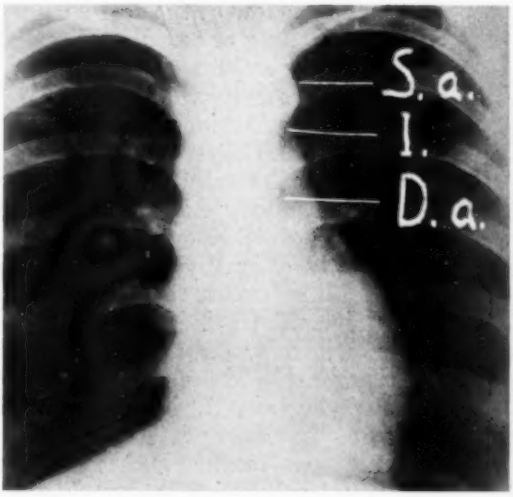


Fig. 8 a.

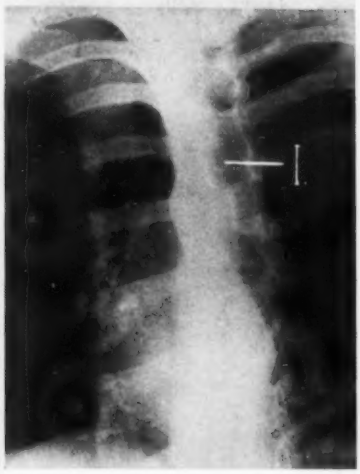


Fig. 8 b.

Fig. 8. Case 3. There are *no changes of the ribs* but a dilated, left subclavian artery (S. a.), an indentation (I.) to the left in the shadow of the posterior mediastinum and an invisibility of the aortic knuckle. Descending aorta (D. a.).

headache, and for the last six months she has had attacks of palpitation latterly accompanied by giddiness and sickness.

Status 2/3 -45: General condition good. Lungs, abdomen, reflexes etc. normal.

Heart: Over aorta a systolic murmur which is also audible over the greater part of the back.

Blood-pressure: In the arm 200/100 mm Hg. In the left leg 125/90, in the right 140/110 mm Hg.

Oscillogram confirmed the changes in the blood-pressure and showed far smaller pulsations in legs than in arms, besides which the leg pulsations showed no increase after work.

No definitely pulsating abdominal aorta is palpable.

Roentgen examination: see fig. 8 and 9.

Operation (CRAFOORD): See fig. 3.

Subsequent to operation the course has been normal.

The operation findings have clearly solved the above mentioned problems of the roentgen picture.

The *left outline of the superior mediastinum* with the part convex to the left is, down to the indentation, formed by the dilated left subclavian artery. The convex outline to the left of the superior mediastinum has earlier been interpreted as the aortic knot, which is easily explained,

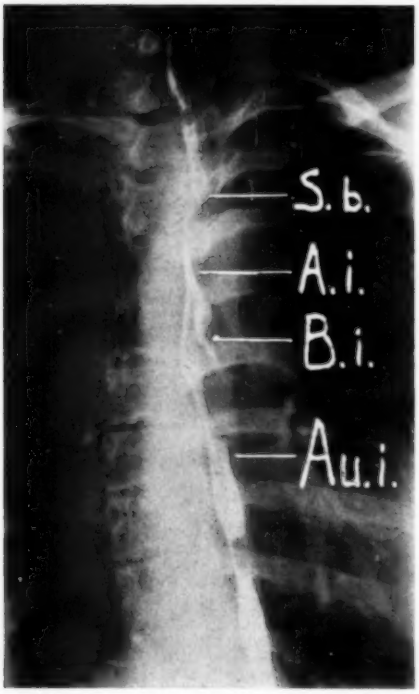


Fig. 9. Case 3. Oesophagus in right anterior oblique position shows normal aortic arch impression (A. i.), left bronchus impression (B. i.) and an impression of the enlarged (?) left auricle (Au. i.). Cranially to the aortic arch impression the *normal*, seeming bulge (S. b.) to the left.

as the shadow of the real knot is either lacking or extremely small, and then projects more caudally than is normally the case.

The left outline of the superior mediastinum often appears normally with a laterally concave curve, which caudally merges into the shadow of the aortic knot but cranially gradually disappears to the same extent as the vessel forming the outline turns into the thoracic wall, and thus no longer stands out in contrast to the tissue conveying air. As has been seen from contrasting injection (Assman), this outline is formed by the left subclavian artery. In the case of coarctation of aorta the outline is straight or laterally convex.

The *indentation* in the posterior mediastinum marks in all the three cases the boundary between the dilated left subclavian artery and aorta.

The *reduced possibility to observe the aortic arch* and the descending aorta, surprising with regard to the hypertension, is due mainly to the dislocation by the shortened ligament of Botalli of adjacent parts of the aorta towards mediastinum but also by tautness of aorta.

Hypertension, whether essential or nephritic, causes partly a dilatation and partly an *elongation of aorta* analogous to what takes place in a water-filled rubber hose, in which the pressure increases. The elongation accentuates the physiological curves of aorta; roentgenologically the ascending aorta appears with an increased curve to the right, the arch rises more boldly in a cranial direction so that the aortic knot projects more cranially and approaches the jugulum, the aortic window becomes larger and the aortic triangle smaller. The increase in size of the aortic knot is a striking feature and depends on the circumstance that the curve round the trachea and the left principal bronchus must take off more markedly to the left.

The arch will thus come further out of the rest of the mediastinum than would otherwise have been the case and will be surrounded more than usual by tissue conveying air, against which it will form a more distinct outline both cranially and caudally. This increases the possibility to observe the arch also in oblique and side pictures. Finally the elongation and dilatation displaces the descending aorta laterally and dorsally going from mediastinum, by means of which this part of aorta will also be increasingly surrounded by tissue conveying air and be better visible in all projections.

A *shortening of aorta* must on the other hand bring about a tautness and consequently a *reduction in its physiological windings*, so that aorta becomes more concealed in mediastinum than would otherwise be the case. The possibility to observe the arch in oblique and side pictures must thus be reduced parallel with the reduction in the possibility to observe the aortic knot.

The operation findings shows three factors, which must cause a tautness of aorta:

I. The extra curve of aorta.

II. The abnormally low pressure in aorta below the coarctation shortens it like a rubber tube dilated with water, in which the pressure is reduced.

III. Shortening of the narrowed parts of aorta adjacent to the insertion of the ligament of Botalli. The transformation of the ductus arteriosus Botalli into the ligament of Botalli includes circular narrowing as well as shortening. The alteration of aorta must be of the same nature. In the 4—5 cm, where aorta is narrowed, must it thus be shortened too.

These three factors produce a shortening of aorta, which counteracts the elongation, caused by the hypertension in the praestenotic part.

The earlier interpretation, that the invisibility of the arch was due to defect or to discontinuity of the arch and was thus a sign of coarctation of aorta and consequently also pathognomonic, the writer considers to be incorrect. Discontinuity of the arch, moreover, would not explain the reduced possibility to observe other parts of the aorta. Numerous cases with extremely small aortic knot and consequently without visible arch in oblique and side pictures are sometimes to be found especially in children, and there are no signs of circulatory disturbances. In such cases the small knot is only an expression of the variation of nature with regard to the length of aorta and the extent of its windings.

Oesophagus normally shows an impression of the aortic arch. Especially when this is strong, oesophagus regains its normal width cranially with a suddenness, that appears to give a bulge of the left outline. This seeming bulge has been misinterpreted as corresponding to the coarctation on aorta. (fig. 9).

Neither in his own cases, examined in frontal (fig. 6), lateral (fig. 5), right anterior oblique (fig. 9) and left anterior oblique views, nor in earlier publications has the writer observed any bulge, that could indicate the coarctated part of the aorta.

Cranially of the seeming bulge has the oesophagus in two of the cases a slight concavity laterally and dorsally. In all probability is this concavity an impression of the right circumference of the dilated left subclavian artery, crossing over the oesophagus on its way from the posterior mediastinum to the anterior wall of the thorax.

SUMMARY

Through observations made at three operations for coarctation of aorta it was possible to determine the anatomical basis for important details in the roentgen picture.

The left outline of the superior mediastinum is formed by the left subclavian artery, the origin of which from aorta is marked on the roentgen picture with an indentation to the left in the shadow of the posterior mediastinum. The reduced possibility to observe the aortic arch and the descending aorta in frontal, oblique and side pictures is found to have a uniform reason, viz. a change in the position of the aorta towards the mediastinum.

The writer finds it contestable that the coarctation can be observed *direct* on the roentgen picture of aorta or in the form of a change in the left outline of oesophagus, and that the impossibility to observe the arch in oblique pictures is due to discontinuity or defect.

A dilatation of the left subclavian artery along with a change of position of the aortic arch and the descending aorta towards the mediastinum and a consequently reduced possibility to observe these parts of aorta will be regarded as pathognomonic for coarctation of aorta. This is of practical value especially in those cases, in which rib defects do not exist.

ZUSAMMENFASSUNG

Durch Beobachtungen während 3 Operationen für Stenosis aortae konnte man die anatomische Grundlage für wichtige Details des Röntgenbildes feststellen.

Der linke Umriss des oberen Mediastinums ist durch die linke Arteria subclavia gebildet, dessen Ursprung von der Aorta auf dem Röntgenbilde mit einem Einschnitt links in dem Schatten des hinteren Mediastinums gekennzeichnet ist. Die reduzierte Möglichkeit den Aortabogen und die Aorta descendens auf Frontal-, Schräg- und Seitenbildern zu beobachten, hat eine einheitliche Ursache, nämlich eine Veränderung der Lage der Aorta gegen das Mediastinum.

Der Verfasser bestreitet, dass die Stenose *direkt* auf dem Röntgenbilde der Aorta oder in der Form einer Veränderung des linken Umrisses des Ösophagus bemerkt werden kann und dass die Unmöglichkeit den Bogen auf dem schrägen Bilde zu beobachten, auf Diskontinuität oder Defekt beruht.

Eine Ausdehnung der linken Arteria subclavia in Vereinigung mit einer veränderten Lage des Aortabogens und der Aorta descendens gegen das Mediastinum und eine dadurch reduzierte Möglichkeit diese Teile der Aorta zu beobachten, werden als pathognomonisch der Stenosis isthmus aortae angesehen. Dies ist von praktischer Bedeutung besonders in den Fällen wo Veränderungen der Rippen fehlen.

RÉSUMÉ

Les observations faites lors de trois opérations de coarctation de l'aorte ont permis de déterminer la base anatomique d'importants détails de l'image radiographique.

La limite gauche du médiastin supérieur est formée par l'artère sous-clavière gauche dont l'embouchure dans l'aorte est marquée par une échancrure gauche dans l'ombre du médiastin postérieur. On constate que la difficulté que l'on a à déterminer la position de la crosse de l'aorte et de l'aorte descendante en incidence oblique, frontale et latérale a comme raison uniforme le déplacement de l'aorte par rapport au médiastin.

L'auteur conteste que la coarctation puisse être observée *directement* dans l'image radiographique de l'aorte sous l'aspect d'une modification du bord gauche de l'œsophage et que l'impossibilité d'observer la crosse de l'aorte en incidence oblique soit due à une discontinuité ou à une perte de substance.

Il faut considérer comme signes pathognomoniques de la coarctation de l'aorte: une dilatation de l'artère sous-clavière gauche combinée à une modification de la position de la crosse de l'aorte et de l'aorte descendante par rapport au médiastin, entrainant une difficulté de l'observation des dites parties de l'aorte. Ce signe a une valeur particulière dans les cas ou les côtes sont intactes.

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KEHLKOPFKREBS NACH STRAHLENBEHANDLUNG[1]

von

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Unter dem Titel »Schwere Kehlkopfschäden, 8 bezw. 11 Jahre nach Abschluss einer Röntgenstrahlenbehandlung wegen tuberkulöser Lymphome» beschrieb LOSSEN in »Strahlentherapie», Bd 56, S. 121, zwei Fälle, von welchen der eine 1917—1920 bestrahlt wurde, wonach 1929 zuerst Tracheotomie und darauf Larynxexstirpation vorgenommen werden musste, und der andere, der 1919—1922 bestrahlt worden war, 1935 von Larynxkarzinom angegriffen wurde.

Während der letzten Jahre habe auch ich zwei Fälle beobachtet, in welchen nach einer früheren Bestrahlung eine maligne Kehlkopfkrankheit entstand.

Der erste Patient (K. G. 86) war im Jahre 1915 im Alter von 16 Jahren wegen tuberkulöser Lymphome bestrahlt worden und zwar im Laufe von 10 Monaten mit 700 x auf den Hals rechts. Wenn wir trotz der Unvollständigkeit des Strahlenprotokolls sehr grob annäherungsweise die angewandte Dosis nach den Zahlen schätzen dürfen, welche SCHUBERT in seiner Arbeit in »Strahlentherapie», Bd. 35, S. 553, angibt, würden in diesen 10 Monaten etwa 20,000 r (!) appliziert sein. Diese Dosis, die uns jetzt erstaunlich erscheint, macht es erklärlich, dass der Patient 1939, jetzt als 40-jähriger Mann, mit einem Röntgenulcus rechts am Halse zurückkam, das trotz Salbenbehandlung keine Neigung zur Heilung zeigte. Das Ulcus befand sich inmitten eines stark sklerotischen Gewebes mit zahlreichen Teleangiektasien, das alle weichen Teile des Halses rechts derart zum Schrumpfen gebracht hatte, dass der Kehlkopf grossenteils rechts von der Medianlinie verlagert war.

Im November 1942 sah ich den Patienten zum ersten Male, jetzt wegen einer Geschwulst des Larynxeinganges, welche als eine höckerige, ulzerierende Masse das linke Ligamentum aryepiglotticum ganz einnahm und den Aditus grossenteils überdeckte. Ausserdem befand sich links am Halse eine Metastase, die bereits die Kapsel durchwachsen hatte und mit der Umgebung, besonders mit dem Gefässnervenstrang, verwachsen war. Die Diagnose wurde mikroskopisch festgestellt.

Nach anfänglicher Weigerung entschloss ich mich, im Dezember 1942 den Patienten, der jetzt fast im Erstickungszustande in das Institut kam, in Behandlung zu

[1] Bei der Red. am 6. VI. 1945 eingegangen.

nehmen, die in einer Tracheotomie bestand, von einer Bestrahlung der am wenigsten geschädigten linken Seite des Halses gefolgt. Auf ein Feld von 10 × 12 cm wurden im Laufe von 5 Wochen 6,400 r (in der Luft gemessen) appliziert, während der Tumor via eine besondere Tube in Sicht gebracht und mittels der Röntgenkontaktröhre, unter Narkose in *einer* Sitzung mit 1,000 r bestrahlt wurde. — Der Patient, der eine starke Hautreaktion bekam, ist vorläufig geheilt. Merkwürdigerweise hat sich auch sein Röntgenulcus rechts am Halse, das zweifellos von der gegenüberliegenden Seite etwas Bestrahlung erhielt, ebenfalls gebessert.

Ein ähnlicher Fall wurde von uns im Jahre 1940 behandelt. Es handelte sich um eine 41-jährige Patientin (K. G. 10385), die mit einem grossen Röntgenkarzinom der Haut in unser Institut kam; das Karzinom war die Folge einer vor 25 Jahren anderswo gegebenen Röntgenbestrahlung wegen tuberkulöser Halsdrüsen. Beide Seiten des Halses waren mehr oder weniger sklerotisch, atrophisch. Die Haut war glatt, dünn, mit Teleangiektasien durchsät und wies hier und dort leichte Excorationen auf. Unter dem linken Ohre befand sich ein Ulcus von reichlich 6×2.5 cm mit mehr oder weniger festen aufgeworfenen Rändern, das unten in eine grosse Geschwulstbildung überging. Dieses Gebilde erwies sich als ein Basalzellenkrebs. Es wurde auf meinen Rat hin im August 1940 mit seiner Umgebung entfernt, und der Defekt wurde mit einem grossen gestielten Lappen aus der Schulter geschlossen. Es erfolgte Heilung, die noch immer andauert; nur klagt die Patientin über Jucken an der anderen Halsseite, das wohl durch die Strahlenatrophie hervorgerufen ist, und das jetzt mit allerlei Salben ziemlich gut beherrscht wird. — Indessen sahen wir die Patientin im November 1943 wieder wegen leichter Heiserkeit und Schluckbeschwerden. Das rechte Arytaenoid war errötet und geschwollen und stand grossenteils in Mittelstellung still. Das rechte Ligamentum aryepiglotticum war ebenfalls, wenn auch in geringerem Masse, geschwollen. Der konsultierte Laryngologe machte eine Probeexzision, worauf die Diagnose verhornendes Plattenepithel-Karzinom mit parakeratotischen Perlen gestellt wurde.

Wegen der starken Schädigung der Haut und des darunterliegenden Gewebes wurde auf äussere Bestrahlung verzichtet und nur innerlich mit der Röntgenkontaktröhre bestrahlt. Die benutzte Tube war 14 cm lang, sodass der Haut-Focusabstand 16 cm betrug. Das kranke Gebiet wurde unter Schleimhautanästhesie mit 20 % Kokainlösung unter genaue visuelle Kontrolle gestellt und mit Pausen von 2—4 Tagen mit Dosen von 700—1,000 r bestrahlt, sodass im Laufe von 4 Wochen *12,500 r* auf das Arytaenoid und dessen Umgebung verabfolgt wurden, welche Dosis eine kräftige fibrinöse Reaktion dieses Gebietes herbeiführte. Die Geschwulst verschwand, wie auch die Schluckbeschwerden und die Heiserkeit, und die Patientin erfreut sich ihrer primären Heilung. Die Zeit wird lehren, ob diese Heilung dauernd sein wird.

Wenn wir nur den ersten Patienten beobachtet hätten, würden wir kaum einen Zusammenhang zwischen der viel früher ausgeführten Bestrahlung und dem Entstehen eines Exolarynxkarzinoms angenommen haben. Da wir aber über zwei analoge Fälle verfügen, scheint ein Zusammenhang zwischen der früheren Bestrahlung und der Krebsbildung wahrscheinlich.

Besonders der letztere Fall scheint dieses Annehmen zu stützen. Schon das Entstehen von Krebs des Arytaenoids bei einer Frau kommt sehr selten vor (hypochrome Anämie, Alkoholmissbrauch und Lues sind nicht vorhanden). Ausserdem spricht auch das verhältnismässig junge Alter beider Kranken sehr für die besondere Ätiologie dieser Geschwülste.

Die zwischen der Bestrahlung und dem Entstehen der Geschwülste verlaufene Zeit betrug in beiden Fällen etwa 25 Jahre, ein Zeitraum, der für das Entstehen von Röntgenkrebsen als nicht zu lang zu erachten ist.

ZUSAMMENFASSUNG

Zwei Fälle von Krebs des Larynxeinganges bei mitteljährigen Personen ohne andere nachweisbare ätiologische Faktoren als zu schwere Röntgenbestrahlung des Halses ungefähr 25 Jahre vor dem Auftreten der Geschwulst, veranlassen den Verfasser, einen Zusammenhang zwischen früherer Bestrahlung und dem Entstehen dieser Kehlkopfkrebse anzunehmen.

SUMMARY

Two cases of larynxcarcinoma in middle-aged persons without any other established etiological factors than strong rœntgen treatment of the throat, about twentyfive years before the appearance of the tumor, cause the author to presume that there is some connection between the previous rœntgen treatment and the manifestation of these laryngeal carcinomae.

RÉSUMÉ

Deux cas de cancer de l'entrée du larynx chez des malades d'âge moyen sans autre facteur étiologique démontrable qu'une irradiation trop intense aux rayons de roentgen du cou, vingt-cing ans environ avant le développement de la tumeur, amènent l'auteur à établir un lien de cause entre l'irradiation et le développement de ces tumeurs.

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THE ROENTGENOGRAPHIC EXAMINATION OF THE ANKLE JOINT IN MALLEOLAR FRACTURES[1]

by

Thorsten Hendelberg, M. D.

In my doctoral dissertation on the fractures of the posterior margin of the tibia in connection with malleolar fractures, I necessarily included a study of the roentgenology of the ankle joint. Instead of being concentrated in a special chapter, my observations in this respect were incorporated in several different chapters where they seemed to be pertinent. One of my opponents criticized this disposition of the roentgenologic material, and remarked that it deserved a section of its own. In the following I have assembled the results of my experiments on autopsy material, as well as observations made on the basis of examinations of fresh fractures (with fluoroscopy and arthrography) and from a survey of a ten year series of malleolar fractures.

In assessing the relation of the fracture line to the insertions of the ligaments on the medial and especially on the lateral malleolus, it is important to determine the roentgen aspect of these ligament insertions on the malleoli, the astragalus and the calcaneum. The roentgenograms of the insertion of the anterior tibiofibular ligament on the fibula are of particular interest in this respect. To this end I therefore inserted a wire through the ligament in an anatomic preparation, of which I then took roentgenograms. As appears from Figure 1, the ligament issues from the often slightly rough lateral distal surface of the anterior tubercle of the tibia, the cortex of which is frequently rather unclearly delineated. In antero-posterior roentgenograms, the ligament is inserted close to the lateral contour of the fibula, while in lateral views it is inserted in the anterior contour of the lateral malleolus, which usually juts out prominently in these views.

The most common fracture of the fibula, *i. e.* the type that runs an infero-anterior and supero-posterior course, often begins below the in-

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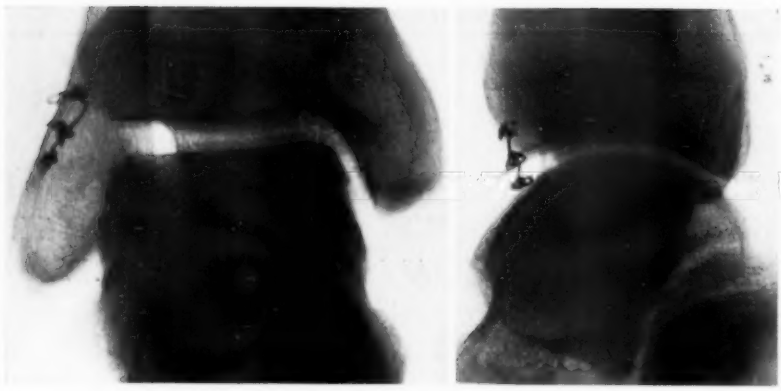


Fig. 1.

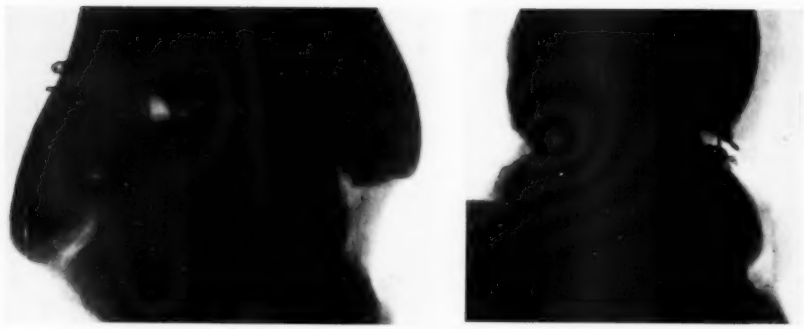


Fig. 2.

sertion of the anterior tibio-fibular ligament, and even if the ligament is undamaged the tibio-fibular mortise is nevertheless insufficient, since only the posterior part of the distal fragment is extensively attached to the tibia by the posterior tibio-fibular ligament. If the fracture begins above the insertion of the anterior tibio-fibular ligament and if the malleolus can be dislocated laterally or laterally and posteriorly, this ligament is invariably torn.

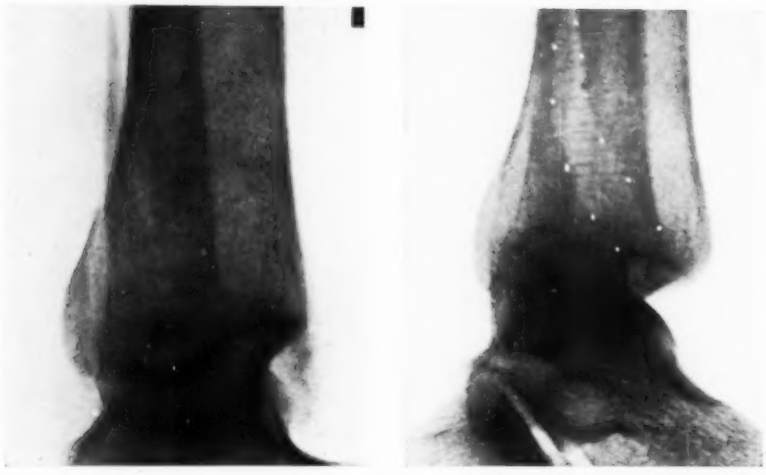
Figure 2 (the same preparation as in Fig. 1) shows the insertions of the lateral ligaments on the medial and the lateral malleolus, an important landmark in interpreting views obtained by arthrography. The medial ligament is seen to arise in the distal surface of the medial malleolus, and its lateral outline lies at the level of the lateral articular

Fig. 3.

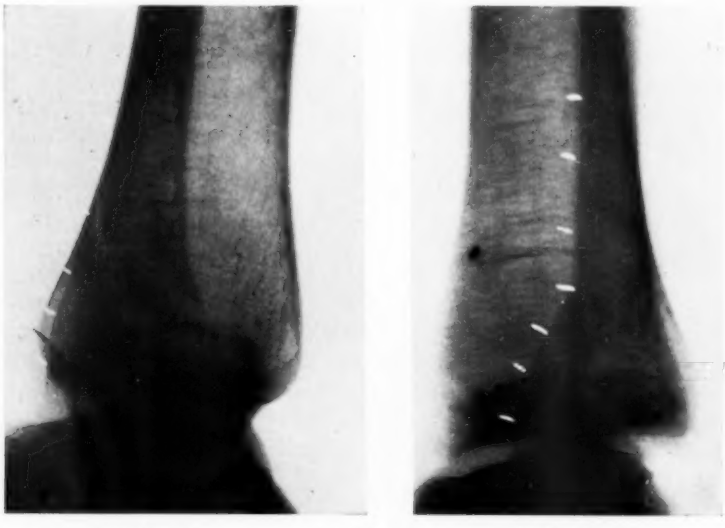
Fig. 4.

surface of the malleolus. The insertion on the astragalus is seen at the level of the distal part of the trochlea tali. The external lateral ligament appears to spring from the most distal part of the lateral malleolus, and its distal insertion is outlined at the level of the subtaloid joint. In the lateral views can also be seen the outline of the anterior capsule below the distal part of the trochlea tali. The posterior capsule was removed in preparing the specimen.

In order to study in greater detail the injuries to ligaments that accompany the malleolar fractures and also to investigate the mechanism of dislocation in various types of fracture, I conducted dislocation experiments under local anesthesia in a number of newly fractured ankles. Applying the elementary rules of the theory of fractures, one may, like LANE, base the classification of malleolar fractures on the mechanism of their origin. Oblique fractures of the malleolus are caused by flexion, transverse fractures by rupture due to traction on the ligaments. A supination injury to the ankle joint would thus take the form of a transverse fracture of the lateral malleolus or rupture of the lateral ligaments, in addition to which an oblique, more or less vertical fracture of the medial malleolus would occur at a later stage. Fluoroscopic examination of a fracture of this type confirmed that considerable dislocation could be produced in supination, in connection with which the center of the astragalus came to lie under the medial part of the tibia (Fig. 3); the fracture was reduced in pronation, but dislocation did not occur in the valgus position. A violence with the leg in pronation would either lead to rupture of the medial ligament or a transverse fracture of the medial malleolus and, at a later stage in the injury to a fracture visible in the antero-posterior roentgenograms as an oblique break in the lateral malleolus, possibly with a cuneiform fragment. Figure 4 shows one of these



Adduction. Fig. 5. Abduction.



Adduction. Fig. 6. Abduction.

fractures which on pronation could be dislocated with the center of the astragalus lateral to the lateral contour of the tibia; not even with a considerable violence could the fracture be displaced into supination. The medial malleolus could be dislocated only about one millimeter medially.

Fig. 7.

Between the pure pronaton injury, which in the antero-posterior view appears as an oblique fracture of the fibula, possibly with an avulsed cuneiform fragment, and the pure abduction (»external rotation») injury, which is oblique in lateral roentgenograms, there are many intermediate forms, and it is not always possible to distinguish fluoroscopically between cases with dislocation mainly on pronation and those with dislocaton mainly on abduction. By abduction I mean the movement of the foot around the long axis of the leg when the foot is rotated outward, by adduction the movement when the foot is rotated inward.

In the typical abduction injury, dislocation experiments reveal that on abduction the distal fragment of the lateral malleolus is either dislocated backwards, the fracture thereby widening considerably (Fig. 5), or else it is bent backward, so that the posterior contour of the fibula is angulated forward (Fig. 6). In both cases complete reduction of the distal fragment occurs on adduction, as appears from the figures.

In 28 of 42 cases examined a definite dislocation tendency could be observed as follows: pronation-abduction, 24; supination-adduction, 2; supination, 2. Of the remaining 14, the dislocation tendency was uncertain in 3 and lacking in 11.

In a number of cases of fracture of one malleolus, injuries to the ligament on the other malleolus were revealed fluoroscopically, and a few cases even showed tears in the ligaments on the fractured malleolus. The ordinary roentgenogram in Figure 7 shows only a fracture of the lateral malleolus of the pronation type, while under the fluoroscope dislocation of the astragalus in pronation disclosed an injury to the medial ligament (Fig. 8).

Fig. 8.

Fig. 9.

Fig. 10.

The uninjured foot was also invariably examined in connection with both the fluoroscopic examinations of fresh injuries and the follow-up examinations of old fractures of the malleolus, and in only one out of approximately 250 cases was it found to exhibit slight instability of the talus. The patient in this case was a woman of very slight build, whose ankles had always twisted easily, and it is not impossible that the instability resulted from an earlier sprain. I was unable to verify the instability of the talus in plantar flexion, which has been described by many

Fig. 11.

anatomists. With the fluoroscope the fibula can be seen to rebound and adapt itself to the breadth of the talus in all positions of the foot. It appears reasonable to assume that a possibility of dislocation which permits widening of the joint space between the talus and the tibia is pathologic, at least if it is not bilateral.

In order to check the results of the fluoroscopic examinations with regard to ligament injuries, all the cases were also examined arthrographically, as follows: 3 cc. of perabrodil was injected anteriorly in the angle between the articular surfaces of the tibia and the medial malleolus, medial to the tendons of the extensors. In 15 out of 16 cases, in which attempts at dislocation failed or in which the fractured malleolus accompanied the talus in dislocation, arthrography showed no leakage of contrast medium outside the joint; the medium was sharply outlined by the synovial membrane (Figs. 9 and 10). The medium passed through the fracture crack, and a tiny patch of medium can be seen in Figure 9 lateral

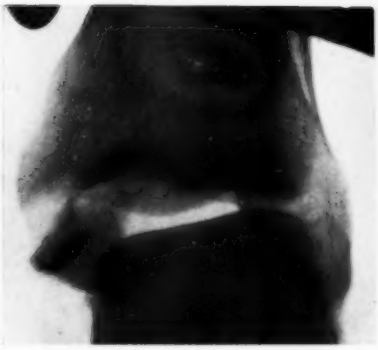


Fig. 12.

Fig. 13.

to the fibula. In one case there was a narrow band of medium below the medial malleolus, indicating a slight capsular lesion in this region. In 9 out of 10 cases in which fluoroscopy revealed an increased distance between the medial malleolus and the talus on dislocation in pronation, leakage of medium below the malleolus was clearly observed on arthrography (Fig. 11). The tenth case was not examined until 24 hours after the trauma, and by that time blood had probably coagulated and sealed in the capsular injury. — In one case manual dislocation in pronation as well as in supination led to a considerable increase in the distance between the talus and the respective malleolus, without, however, arthrography revealing leakage of contrast medium. This was probably due to the hematoma having coagulated when the patient was examined three days after the injury. It is obviously important to exercise great caution when evaluating radiographs when arthrography is made after some time has passed since the injury.

Figure 12 shows a case in which the medial malleolus accompanied the talus with an increased distance on experimental dislocation and in which arthrography disclosed that contrast had made its way both into surface layers through the fracture in the medial malleolus and into deeper layers directly from the medial recess of the joint through the capsular rupture (Fig. 13). The different levels of the two layers appeared clearly in stereoscopic pictures. Obviously the trauma consisted of two phases of movement, one of them — probably pronation — causing the tear in the ligament, and the other — possibly abduction of the talus — leading to the fracture of the medial malleolus.

Fig. 14.

The combination, abduction fracture of the lateral malleolus and damage to the lateral ligaments, was also seen. In this particular case, it was possible on dislocation in supination under fluoroscopy to see lateral widening of the joint space and also an increase in the distance between the talus and the lateral malleolus. On arthrography the contrast medium leaked below the apex of the lateral malleolus (Fig. 14). Supination-abduction may be imagined to give rise to this combination of fracture and lesion of the lateral ligaments; the latter injury is generally claimed to be a great rarity.

In a few cases, in which experimental dislocation led to suggested increase of the joint space of one or two millimeters, arthrography disclosed no capsular leakage. A slight stretching of the ligaments is conceivable here, but not to the point that any real rupture of the capsule occurred. Thus the same conclusions regarding injuries to lateral ligaments can generally be drawn from the two methods of examination, on condition that they are performed within 24 hours of the trauma. In occasional cases, however, the two methods complement one another.

Rupture of the tibio-fibular ligament can only be definitely diagnosed in cases of major dislocation. As PALMER also observed, the mortise can be widened about one centimeter if the anterior tibio-fibular ligament has been torn or detached. More exactly, the anterior breadth of the mor-

Fig. 15.

Fig. 16.

tises is enlarged, while the posterior remains unchanged. This widening may escape detection with ordinary roentgenography. In Figure 15 a 7- to 8- mm. wedge of wood was inserted between the talus and the fibula after detachment of the anterior tibio-fibular ligament. There is no difference in the breadth of the tibio-fibular joint or of Chaput's *ligne claire* in this roentgenogram and the next one (Figure 16), which was made without any wedge. It is clearly the posterior, nondislocated margin of the fibula that formed the contour medially, which would explain why the widening was not visible. Several different methods of determining the width of the space between the fibula and the tibia have been published. HUSFELDT, who tested them all in a series of cases, stated that the various methods did not give the same results with one and the same case. In dislocation under the fluoroscope the examiner can see how the tibio-fibular articulation can be widened, and the observations made with this method can be verified with arthrography; a band of contrast medium can be followed up through the tibio-fibular articulation, and abundant medium will be found in the region of the interosseous membrane (Fig. 17). In one case, in which no dislocation could be observed fluoroscopically, arthrography revealed contrast medium in front of the anterior tibio-fibular ligament, indicating lesion in that region. Otherwise, rupture of the tibio-fibular ligament was not diagnosed arthrographically in any case. Unless the rupture was large enough to appear in the direct roentgenograms or to be visible on manual dislocation under the fluoroscope, contrast fluid was never observed to have made its way through the tibio-fibular articulation.

STEVENS (1924) claimed on the basis of purely geometrical calculations that tilting of the talus in supination or pronation would produce, through a wedgelike action, either a fracture or a rupture of the tibio-fibular arti-

Fig. 17.

culation. That this is not the case is indicated partly by postmortem experiments which I have made and partly by a study *in vivo* of a case of severe ligamentous injury without fracture, in which the talus could be considerably dislocated in pronation and even more in supination (Fig. 18) without any diastasis of the tibio-fibular articulation being visible either with fluoroscopy or arthrography. (Fig. 19).

Evaluation of the lateral views in arthrography is attended by a number of difficulties. The injection is made at the anterior recess, and small amounts of medium may escape here along the track of the needle. Larger amounts of medium above the neck of the talus and down toward the talo-navicular articulation or in front of the tibia, which are found in practically all cases with a posterior marginal fragment, are probably due to leakage through a tear in the anterior recess of the capsule; this fluid may even make its way out through the fracture of the medial malleolus. However, the fact that large patches of medium are regularly found in cases with posterior fragments, when the anterior recess is undoubtedly often injured due to backward luxation, suggests that the leakage takes place through the capsular injury. Analysis of these details is not always possible either with stereoscopic pictures or by comparison between films taken in different planes. Leakage of contrast

Fig. 18.

Fig. 19.

medium on the posterior aspect of the joint was only seen in cases with posterior marginal fragments, and hence the posterior articular capsule apparently as a rule was uninjured. The tendon sheath of the flexor hallucis longus was definitely filled in three cases and possibly filled in two others; according to LANZ and WACHSMUT, there is not seldom a communication between the posterior portion of the articular capsule and this tendon sheath, and filling of the tendon sheath is thus not pathologic.

These examinations with fluoroscopy and arthrography are of theoretical as well as practical interest. They serve on the whole to confirm the theory of the mechanism of fractures which hitherto has been subscribed to and on which ASHHURST and BROMER based their classification. However, I found cases in which movement combinations not previously demonstrated clinically, such as supination—abduction, appeared to have contributed to the fracture. It was also possible to chart in detail the various injuries to ligaments, which I found to be both more common and more extensive than previously believed; in some cases both ligament injury and fracture were observed in the same malleolus.

Examination with fluoroscopy is also of clinicotherapeutic interest. It provides information as to the manner of dislocation and thus indicates the direction which the reduction should take. Further, if the surgeon himself makes the examination, he is able to carry out reduction under visual control and appraise the effect of the various manipulations as well as the force required in order to achieve the objective, the most exact reduction possible.

Fig. 20.

Fig. 21.

The roentgenogram of the posterior tibial fragment is unsatisfactory in the routine projections. These types of fracture have been classified clinically by FELSENREICH and NELSON & JENSEN according to their extent in the sagittal plane, measured either in millimeters or expressed in the fraction of the articular surface included in the fragment. The latter is of very little use, however, in cases in which the central ray is not in the same plane as the fracture surface.

A study of a series of cases collected over a period of ten years at the Appartment of Surgery of the University of Upsala revealed that in only 27 of 160 cases was the posterior fragment clearly delineated. This is explained by the abovementioned relation between the central ray and the plane of the fracture surface. In the other cases all that could be determined was that the fracture surface was in an oblique plane,

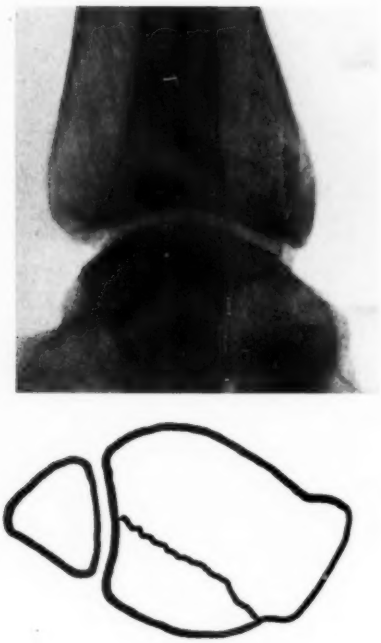


Fig. 22.

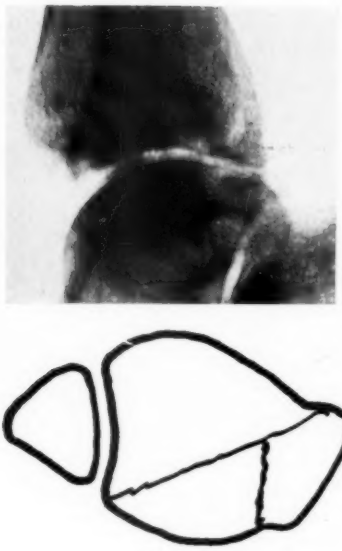


Fig. 23.

which however could not be studied in any detail in the roentgenograms.

In experiments on cadavers I was able by means of lateral blows on the medial articular surface of the fibula to detach a fragment of the cortex measuring 1 × 1 cm. from the insertion on the tibia of the posterior tibio-fibular ligament. Nevertheless this fragment was not visible in the lateral roentgenograms, despite the fact that the rays were directed sligthly from the back laterally (Fig. 20; the sketch shows the position of the fracture line in the articular surface seen from below). Nor was the fragment visible in antero-posterior roentgenograms. Small avulsions from the insertion of the posterior tibio-fibular ligament on the tibia could not be seen either in lateral or antero-posterior views, and there is obviously little chance of visualizing such fragments roentgenographically unless they have been considerably dislocated.

In addition, I have produced in autopsy material true posterior marginal fragments of various sizes in order to study their roentgenographic aspect. In Figure 21, no posterior fragment can be seen, although in this case a fragment comprising two-thirds of the posterior margin of the

tibia had been chiseled out. Nor is any posterior fragment visualized in Figure 22, a lateral view; here the chisel was applied slightly lateral to the posterior margin of the medial malleolus and approximately facing the center of the lateral malleolus. In lateral views, particularly if the rays are directed laterally and slightly from the front, there is a dead angle between the posterior contours of the tibia and the fibula, where even fairly large posterior marginal fragments may escape detection. In the aforementioned series, posterior fragments were overlooked in four cases at the first roentgen examination, and it was not until control films were taken later when the rays were directed laterally and slightly from the back that the fragments were clearly visualized. No more than abdominal palpation can be considered complete without rectal examination can roentgen examination of an ankle fracture be considered terminated until views have been taken in this plane. The foot should be rotated so as to make the posterior fibular contour coincide as closely as possible with the posterior tibial contour. This projection allows of greater possibilities of visualizing a posterior fragment. However, small posterior cortical fragments caused by a rupture of a ligament sometimes escape detection in these views, too. Since these cortical fragments are not visible in routine roentgenograms, this term should not be used when describing posterior fragments, since it is misleading as to the size of the fragment in question. The lateral part of the posterior fragment is most often broader, while the medial part of fragments visualized as thin, cortical avulsed fragments may include almost half the articular surface, without this circumstance being revealed in the roentgenograms.

Figure 23 represents a case in which the chisel was applied to the anterior margin of the medial malleolus and the posterior margin of the lateral malleolus; here, the lateral view shows a fragment which would be judged to include less than one-quarter of the articular surface. In this experiment Y- or T- fracture developed, which, as appears from the sketch, ran out toward the posterior margin of the medial malleolus. Since this kind of fracture also developed in other experiments, where the fragments were produced by blunt violence to the articular surface, it is probably due to structural conditions in this part of the tibia.

In the roentgen examination of cases with posterior fragments, views are occasionally secured which appear to indicate that the posterior part of the medial malleolus and the posterior fragment form a continuous block. In none of the operated cases in my series, however, was this found to be the case; instead, the medial malleolus was separated from the posterior fragment by a Y- fracture, as in the above experiments on cadavers. In antero-posterior views in these experiments, the fracture is visualized as an almost vertical break in the medial malleolus (Fig. 24), which, judged by ASHHURST's and BROMER's chart, would be a bending

Fig. 24.

fracture caused by supination. It may be that findings of this kind were what led certain workers (LUDLOFF) to group some of the fractures of the posterior margin of the tibia as inversion or supination fractures.

One or two possibilities of judging the size of the posterior fragment still remain. Since, when filming in the lateral views, the rays pass more or less tangentially the vertices of the saddle-shaped articular surface of the talus and the tibia, the cortical layers here will be relatively thicker, and arched lines of increased density will be seen in the views of the tibia and of the articular surface of the talus. If the rays are directed so that the same ray does not strike both the lateral and medial vertices, two parallel arches will result, one above the other if the ray comes from above or below and intersecting if the ray comes from behind or in front. With posterior fragments the break in these arches in the tibial articular surface cannot seldom be seen; if the centering of the ray and the relation of the arches to the anterior and posterior contours of the fibula are taken into consideration, it is generally possible to determine which of the arches is medial and which is lateral. When the ray is directed from the medial aspect and somewhat from behind, the medial arch will be outlined in front of the lateral one, and the anterior termination of both arches will lie in front of the anterior margin of the fibula which is situated relatively far back in the view of the tibia. If the ray is directed from the medial aspect and somewhat from the front, the fibula will be more to the front in the view of the tibia, and the anterior termination of the medial arch will lie behind that of the lateral arch; if the rotation is not too pronounced, the lateral arch with its anterior termination is generally situated beside or slightly in front of the anterior contour of the fibula.

Sometimes the relation between the posterior portions of the arch and the medial malleolus provides guidance as to which is the medial or lateral arch. The length of the radius, as well as the sharpness of the arches, may also be informative in this respect.

In 44 of the 160 cases I studied, a break could be seen in either one or both of the arches, from which could be deduced the position of the fracture surface in the medial and the lateral parts of the joint. An ob-

servation made in only 44 of 160 cases might seem to be of scant diagnostic value, but these cases were part of a series examined by routine roentgenographic methods only, with no attempt to secure oblique views. In experiments with cadavers, I produced posterior fragments with chisel, or hammer, and roentgenograms of the preparations showed that the breaks in the arches occurred at the points where, according to the records of the experiments, the fracture surface intersected the respective vertices in the tibial articular surface. On the fragments these arches varied slightly; in some cases they were not visible, in others only one could be seen; in still other cases the lines were visualized in certain views and not in others. This is probably due to the fragment having been dislocated so that its vertices did not intersect in the plane of the tibial articular surface and to the fact that both the dislocation and the plane of the rays may vary slightly in different exposures.

With suitable oblique views, it is thus possible to estimate the position of the arches medially and laterally and to determine the point at which the fracture meets the arches, thereby forming an opinion of the extent of the posterior fragment in the sagittal plane in the medial and the lateral part of the tibial articular surface.

The size and configuration of the fragment can sometimes be estimated in antero-posterior views also. As GRASHEY (1905) observed, an area of increased density is not seldom seen with this projection in the inferior end of the tibia in the form of an inverted V; this finding results from dislocation, usually cranial, of the posterior fragment, in which case the doubled cortex leads to increased density. When the fragment is dislocated sideways, the dense patch in one margin of the fragment is matched by a rarefied area in the other. In a relatively large number of cases with or without the V-shaped dense area, slight cloudiness is sometimes found in the region of the cranially dislocated fragment. This cloudiness may be so faint as to hardly warrant being considered pathologic; it may also be very pronounced. It is characterized by a certain lack of sharpness in the design of the trabeculae with haziness between them. This phenomenon is most clearly observed in the area above the epiphyseal line, which takes on a relatively greater sagittal width in cranial dislocation of the posterior fragment, which is in the form of an upright wedge. A contributory cause of this haziness might be disorganization of the trabecular structure or the presence of blood clots, etc. However, in experiments with cadavers, in which the posterior fragment was produced mechanically and disorganization was therefore negligible and there were no blood clots, the same pictures were secured after cranial dislocation of the fragment. Hence, dislocation in itself suffices to produce the haziness.

In my series, cloudiness with or without a V- or U-shaped shadow

was present in 71 of 160 cases, and in them the breadth of the posterior fragment in the frontal plane could be deduced from the configuration of the cloudiness or from the dense area. It is primarily the medial outline of the fragment that is of clinical interest. On the basis of all the above observations, the fragment was found to include the lateral three-quarters or more of the posterior tibial margin in 65 out of 71 cases. In three cases it included two-thirds to slightly more than three-quarters and in three cases less than two-thirds of the posterior tibial margin. In antero-posterior roentgenograms it is sometimes possible to see a portion of the articular surface on the fragment; here the fragments are generally large ones in the sagittal plane and include one third to one half of the articular surface in this plane with considerable cranial dislocation. The defect on the posterior tibial margin can only be seen in these views in exceptional cases.

When estimating the size of a posterior fragment, the examiner should bear in mind the special projection conditions that arise in a non frontal fracture surface. In these cases the thin marginal fragments resulting from avulsion are generally not seen; even large fragments may be concealed in the dead angle behind the tibia. Oblique views, investigation of possible breaks in the arched lines in the tibial articular surface, and the presence of V- or U-shaped dense areas as well as of cloudiness in the tibia above the epiphyseal line in antero-posterior views, may be helpful in interpreting the posterior fragment, regarding which routine roentgenograms provide little information of value.

SUMMARY

The mechanism of dislocation in different forms of malleolar fractures has been studied under the fluoroscope. The investigation provided valuable data as to the origin of malleolar fractures, the extent of injuries to ligaments, and the effect of different manipulations to achieve exact reduction. Arthrographic examinations of malleolar fractures corresponded well with the fluoroscopic studies with regard to ligament injuries, on the condition that they were made during the first 24 hours after the trauma. In some cases arthrography disclosed minor injuries to ligaments which escaped detection with fluoroscopy. Experiments on cadavers revealed that even considerable widening of the anterior part of the tibio-fibular mortise are not visualized in the roentgenograms. They also showed that views taken in the two routine planes do not give a complete picture of the size of the posterior tibial fragment. Thin, cortical marginal fragments removed with the chisel were not visualized at all. Fragments which in the roentgenograms appear as such fragments include varying expanses of the articular surface, often very large. The relation between the direction of the rays and the plane of the fracture surface determines the appearance of the roentgenogram. The writer recommends making it a rule to take a view from the back laterally. Breaks in the arched lines in the tibial articular surface formed by the vertex of the saddle-shaped articular surface are sometimes informative as to the course of the fracture line in the medial and lateral part of the joint.

ZUSAMMENFASSUNG

Verf. hat mittels Durchleuchtung den Weg der Dislokation bei verschiedenen Formen von Malleolarfrakturen studiert. Diese Untersuchungen geben wertvolle Aufschlüsse über den Entstehungsmechanismus der Malleolarfrakturen, den Umfang der Ligamentverletzungen und die Wirkung der verschiedenen Handgriffe zur Erreichung einer exakten Reposition. An frischen Malleolarfrakturen vorgenommene arthrographische Untersuchungen zeigen inbezug auf die Ligamentverletzungen zumeist gute Übereinstimmung mit den Durchleuchtungsuntersuchungen, falls die Arthrographie nämlich in den ersten 24 Stunden vorgenommen wird. Hin und wieder zeigt diese kleinere Ligamentverletzungen, die bei der Durchleuchtung nicht entdeckt wurden. Experimente an Sektionsmaterial zeigen, dass selbst eine bedeutende Auseinandersprengung der vorderen Partie der Gabel im Röntgenbilde nicht sichtbar wird. Leichenversuche ergeben ferner, dass Röntgenaufnahmen in den zwei gewöhnlichen Projektionen unvollständige Auskünfte über die Grösse des hinteren Tibiafragmentes geben. Dünne abgemeisselte Fragmente aus corticalis waren überhaupt nicht sichtbar. Bruchstücke, die im Bilde als Schalenfragmente erscheinen, umfassen grössere oder kleinere Partien der Gelenkfläche — oft sehr grosse Partien; das Verhältnis der Strahlenrichtung zur Bruchebene bestimmt das Aussehen des Bildes. Verf. empfiehlt, immer eine Aufnahme mit einer Strahlenrichtung von hinten-medial zu machen. — Unterbrechungen in den Bogenlinien der Tibiagelenkfläche, die durch den Scheitel der sattelförmigen Gelenkfläche bedingt sind, können bei der Beurteilung des Verlaufs der Bruchlinie in der medialen oder lateralen Partie des Gelenks Anhaltspunkte darstellen.

RÉSUMÉ

L'auteur a étudié au moyen de la radioscopie le mécanisme de la dislocation dans diverses formes de fractures malléolaires. Ces recherches fournissent des informations de valeur sur le mécanisme de la fracture, sur l'étendue des lésions ligamenteuses et sur l'effet des diverses manipulations nécessaires à une réduction exacte. Des recherches faites dans les cas de fractures malléolaires fraîches au moyen de l'arthrographie donnent, en ce qui concerne les lésions ligamenteuses, en général, des résultats comparables à ceux de la radioscopie, lorsqu'on pratique l'arthrographie durant les premières vingt-quatre heures. Elle révèle parfois de légères lésions ligamenteuses ayant échappé à la radioscopie. Des expériences faites sur matériel d'autopsie démontrent que l'image radiographique ne révèle pas l'élargissement, même considérable, de la partie antérieure de la fourchette. Des expériences sur le cadavre démontrent aussi que les radiographies prises dans les deux projections habituelles ne renseignent qu'incomplètement sur la grosseur du fragment postérieur du tibia. Des éclats de la corticale de l'os sont invisibles. Des fragments qui, sur la radiographie, ont l'air de fragments de corticale comprennent toujours une portion plus ou moins grande de l'articulation, parfois même des portions très considérables; c'est l'orientation des rayons par rapport au plan de la surface de la fracture qui détermine l'aspect de l'image. L'auteur fait une règle de la prise d'une image de derrière avec projection latérale. Une interruption des lignes arquées de la surface articulaire du tibia, formée par le vertex sur la surface sellare de l'articulation, peut donner des indications pour l'appréciation du parcours de la ligne de fracture dans les parties interne et externe de l'articulation.

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A CALCIFIED CYST OF THE SPLEEN, DEMONSTRATED ROENTGENOLOGICALLY [1]

by

Erling Kierulf

Calcifications in the region of the spleen are not rare and they are now demonstrated roentgenologically relatively often. An accurate diagnosis can be made with considerable certainty according to the size, form and location of the calcification. When the calficications are localized to the spleen, and when they are small and usually multiple, they are due to phleboliths, tuberculosis or parasites. When the calcifications are larger, usually not multiple, they are due to infarcts, hematomata, abscesses or cysts. They may also be due to calcifications in the vessels of the spleen. In recent years aneurysm has been described most frequently, either single or multiple, both types are equally common.

The cysts are classified as follows according to FOLIERI:

1. Non-epithelial pseudocysts.
2. True serous-bloody cysts.
3. Angiomatous cysts.

FOWLER classifies the cysts into

A. True cysts, and B. pseudocysts.

A. is classified into:
   1. Infoliation cysts (folding in of the peritoneal tissue).
   2. Dilatation cysts (multiple lymph cysts).
   3. Neoplastic cysts (lymphangioma and hemangioma).

B. is classified into:
   1. Traumatic cysts.
   2. Degeneration cysts.

HENKE-LUBARSCH classifies the cysts into:

A. Parasitic cysts.

B. Non-parasitic cysts.
   1. Small multiple cysts.
   2. Usually single, larger cysts.

[1] Submitted for publication, June 5, 1945.

According to their content a distinction can be made between cysts which contain clear fluid and those which contain a blood-colored or bloody fluid, and finally the very rare dermoid cysts.

The solitary cysts are assumed to arise from several cavities. The cyst wall is usually thin, and where the cyst does not reach the surface of the spleen the capsule is thickened with connective tissue. The cyst wall consists of connective tissue with few elastic fibres. The small cysts usually have a cubic endothelium, this is lacking in the larger cysts or is only partially present in the form of a squamous endothelium. This is believed to be due to the pressure effect of the contents of the cyst. The solitary cysts are assumed to be cystic lymphangiomata, as this is more probable than that they originate from blood vessels. A simple classification of the large cysts is to divide them into true cysts and pseudocysts.

Calcified cysts of the spleen have been demonstrated roentgenologically by FÖLDES in 1926, VON GATERSLEBEN in 1928, BAUMANN and KOHNSTAMM in 1930, NOLTE in 1936, BACHMANN in 1939, ZDANSKY in 1941 and 2 cases by v. KEISER in 1942. In the literature obtainable at present I have not been able to find other published cases.

The differential diagnosis between a cyst and an aneurysm may be difficult. Aneurysms vary considerably in size, they are usually smaller than 3 cm. in diameter, but have been described up to 7 cm. in diameter (according to BACHMANN). If the calcification is large, ring-formed and partially broken, the more medial localization, calcification in the arteria or vena lienalis or in the aorta abdominalis, indicates the diagnosis aneurysm.

This case is a man born 15. 4. 1905 who in August 1939 was sent in for roentgen examination of the stomach and duodenum. He had had a vague sensation of weight in the left side of the abdomen, had otherwise been healthy.

To the left of the stomach without dislocating the latter, two calceous ring shadows 3 and 4.5 cm. in diameter were visible (Fig. 1). In the lateral view the ring shadows were projected partly on the columna shadow (Fig. 2). In an oblique view, after intravenous injection of urotrast, the ring shadows were projected in the region of the spleen free of the kidney shadow. (Fig. 3.)

The diagnosis calcified echinococcus cyst was regarded as eliminated as the patient had not been outside the country. The diagnosis of a spleen cyst was considered, but as I thought at that time that the large cysts were always solitary and were localized to the lower half of the spleen, aneurysm was regarded as the most probable diagnosis.

On 30. 8. 1939 a splenectomy was performed by ASBJ. NILSSEN. The spleen was considerably enlarged and firm. A number of veins led from the cauda pancreatis over to the hilus lienis. The gross specimen is illustrated in Fig. 4.

Microscopical examination (Prof. L. KREYBERG): Outwardly the cyst wall consists of a fibrous layer with few cells, within this there is an area more rich in cells, and here there are indications of the development of small, secondary cysts, limited by a thin, cubic cell layer. The microscopical picture when considered together with the macroscopic, indicates decidedly that there is no aneurysm, but a multi-chambered cyst with calcifications in the cyst wall. Diagnosis: spleen cyst.

Investigation in March, 1944, reveals that the patient is in good health and at work.

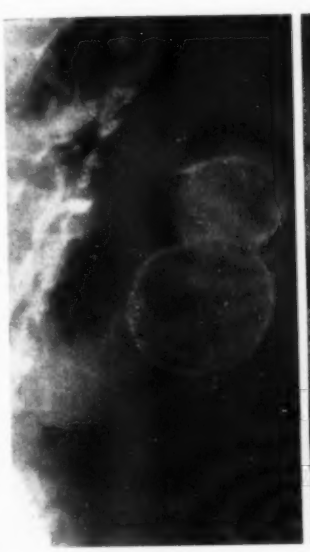

Fig. 1.

Fig. 2.

Fig. 3.

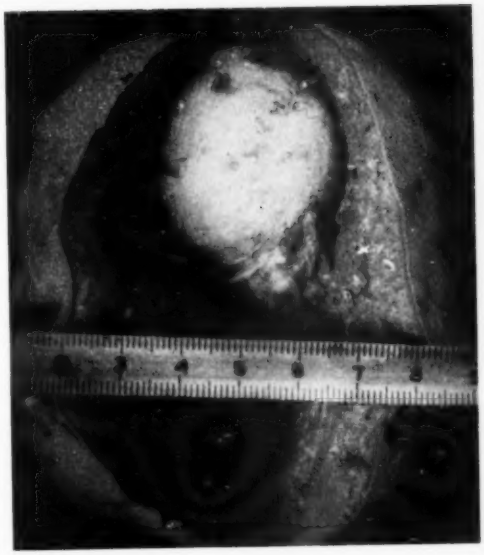

Fig. 4.

SUMMARY

After a brief description of calcifications in the spleen and the classification of spleen cysts, a case of a roentgenologically demonstrated spleen cyst in a 34-year-old man is described.

ZUSAMMENFASSUNG

Nach einer kurzen Beschreibung der Verkalkungen in der Milz und der Einteilung der Milzcysten, wird ein Fall von röntgenologisch dargestellter Milzcyste bei einem 34jährigen Manne wiedergegeben.

RÉSUMÉ

L'auteur, après avoir décrit les calcifications de la rate et exposé leur classification, rapporte un cas radiologiquement constaté de kyste de la rate chez un homme de 34 ans.

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STUDIES ON A. C. ARC LAMPS[1]

by

K. G. Hansen

The first experiments in using a. c. arc lamps for light treatment purposes in this country were made by Prof. LOMHOLT in 1935. Shortly later came Dr. A. SAUGMAN's magazine lamp, which, however, first was described in his thesis for the doctorate 1944 (p. 40).

In the following will be given a description of the *Universol* lamp, the a. c. arc lamp which The Finsen Institute has employed since 1940, and which was designed by Inspector FR. NIELSEN and the author. In addition, an account will be given of some comparative studies of the Universol lamp and the magazine lamp.

In our opinion, the chief quality of a light treatment lamp should be the production of a *constant arc*. This would require a regulating mechanism permitting a continuous and fine adjustment; we found that the differential principle applied on the Ferraris system was suitable for the purpose, and so we decided to use this method.

The next important factor had to be the *characteristic of the transformer*. The secondary voltage and current conditions of the transformer would have to be adapted to compensate for the natural instability of the arc. This is attained by means of an open-circuit transformer. *Fig. 1* shows the characteristic curve of the applied transformer. A slight increase of current near the working point, i. e. about 55 volts and 25 amperes, will cause a perceptible voltage drop and immediately actuate the mechanism, causing, in turn, the current to diminish to the desired rate (25 amperes). Furthermore it appears from the curve that the short-circuiting of the transformer occurring in the moment when the arc is struck will only involve a limited short-circuit current (35 amperes at the outside). This will not cause glowing carbon particles to burst loose, nor involve embarrassing voltage variations on the mains. A slight draw-

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back of this transformer is that it costs a little more to make than the transformers generally used, and its efficiency is a few per cent. lower provided that the transformers are constantly working with full load. The efficiency of the open-circuit transformer is 93—94 per cent., that of the usual transformers is 96—97 per cent.

Fig. 2 shows the principle of *the regulation of the Universol lamp* by means of the Ferraris system.

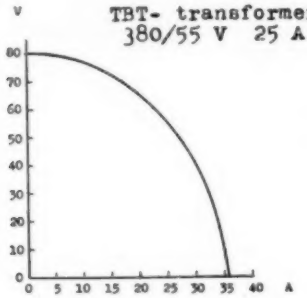


Fig. 1.

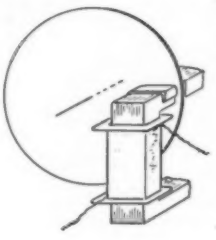


Fig. 2.

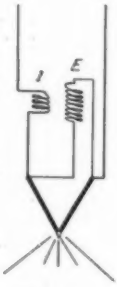


Fig. 3.

Fig. 1. Characteristics of transformer used for the a. c. Universol lamp. The secondary tension (ordinate) decreases with increasing current (abscissa). The steep gradient of this curve in and around the working point (25 amperes, 55 volts) is a condition for the fine regulation of this lamp.

Fig. 2. Sketch of the Ferrari system used in the Universol lamp; the aluminium disc and one controller magnet are shown.

Fig. 3. Wiring diagram of the a. c. Universol lamp.

The pole pieces of the two a. c. magnets which form part of the feeding mechanism are slotted, and a thick copper ring is fitted around the one half of the pole pieces. Between the magnet poles is mounted an easily rotatable aluminium disc, and eddy currents set up on the copper ring and aluminium disc produce a driving torque on the latter which makes it rotate.

The wiring diagram of the lamp is shown in *Fig. 3*. *I* denotes the »current» coil and *E* the »voltage» coil. These coils act as exciting coils, each for one magnet: the »current» magnet and the »voltage» magnet which can be seen in *Fig. 4a*. The magnets are mounted on either side of the axis of the aluminium disc in such a way as to make them affect the disc with driving torques of opposite directions in accordance with the well-known differential principle, thus giving a very fine adjustment of the lamp. As the carbons burn away, the current *I* diminishes, and the force of the »current» magnet decreases. This brings about that the torque of the »voltage» magnet on the disc becomes the stronger: the disc will

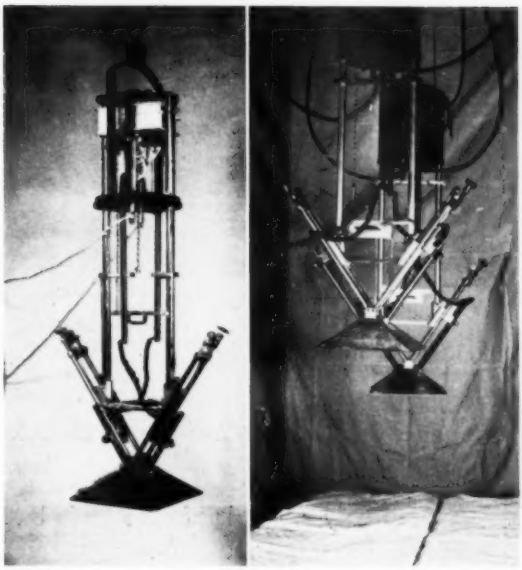


Fig. 4 a. Fig. 4 b.

Fig. 4 a. Universol lamp with uncovered regulating mechanism.
Fig. 4 b. A system of Universol lamps.

rotate, causing the carbons to move towards each other, and the current increases again. If the carbons are brought too close together, the arc voltage will become too low, thereby de-energizing the »voltage» magnet and, in turn, enabling the »current» magnet to rotate the disc so as to separate the carbons. Thus this beautiful regulating system will react upon small variations of *current* as well as of *voltage:* so the stability of the lamp is ensured. Besides, the arc is protected against draught by means of a protecting screen shade which can also be seen in *Fig. 4.* The carbon holder system is the same as that hitherto used in the d. c. lamps of The Finsen Institute. In the open-arc lamp the hot air around the arc will constantly pass upwards and, more or less, pull the arc upwards too, causing irregular variations in the latter. The screen reduces this nuisance quite considerably. Furthermore it is a great comfort for the staff and the patients that the light is not radiated in all directions: thus, the staff can completely dispense with the protective spectacles formerly used. The screen does not reduce the irradiation on the patients, which appears from *Fig. 5,* showing a light distribution curve for the Universol lamp. The patient is lying in the angle space between 30° and 40° approximately.

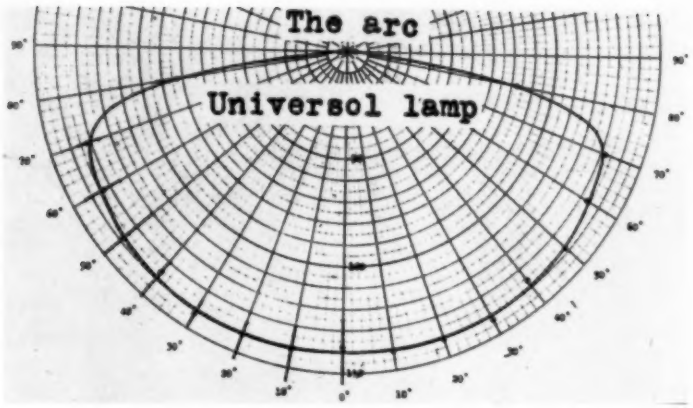


Fig. 5. Distribution of the ultra-violet A emission of the Universol lamp.

In one Universol lamp only one pair of carbons is burned at a time. Trimming is necessary after about 8 hours' run, and during these 8 hours the carbons need only be pulled forward once, which is an advantage of this lamp as compared with *e. g.* the magazine lamp, *Figs. 6 a and 6 b.* During the run of the latter — which has no automatic feeding of the carbons — the lamp must be extinguished at intervals of about 2 hours in order that the 32 carbons (16 in each section) with which the lamp is provided, may be moved forward in their holders.

A set of Universol lamps consists of two 1.5 kilowatt lamps placed so as to give a good distribution of light on both patients (*Fig. 7*).

The measurement of the ultra-violet A emission of the lamps was made by means of a selenium photo-electric cell (Zierold, Type 25) covered by a special ultra-violet filter (»Dunkeluviolglas»). The transmission ratio of the filter measured thermo-electrically is shown in *Fig. 8* and corresponds rather closely to that of the U. G. 1 filter (2 mm). It will appear that the transmission is rather good within ultra-violet A, i. e. from 3 800 to 3 200 Å. U. The photo-electric cell is sensitive within this range although the latter is not identical with the optimum range of sensitivity of the cell. The filter has a very small transmission around 7 500 Å. U., but here the P. E. C. fails, so this combination is well qualified for the purpose. The P. E. C. was covered with a mask. Experiments proved the existence of proportionality between intensity of illumination and photo-current, with a fixed mask aperture, when the P. E. C. was short-circuited; in our test arrangement the P. E. C. circuit was closed through a galvanometer having a resistance of 3.7 ohms. We found furthermore

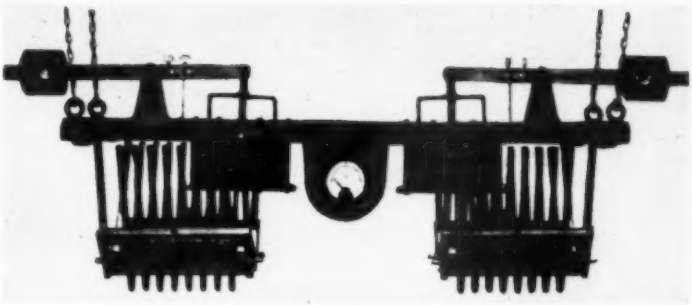


Fig. 6 a. Magazine lamp (A. SAUGMAN).

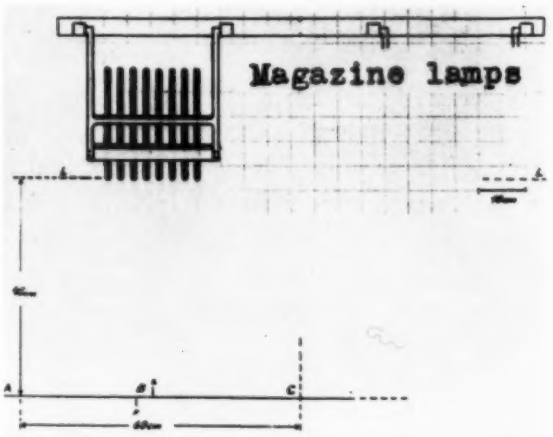


Fig. 6 b. Position of the planes A, B and C where the emission from the magazine lamp was measured.

that the sensitivity of the P. E. C. would vary proportionally to the illuminated area when the mask aperture was altered: this was what we needed in order to compare the light emissions of the two lamp systems.

The applied galvanometer was a self-recording multiflex galvanometer with electrocardiograph paper, which was the most sensitive paper we were able to get.

The P. E. C. was mounted on an arm 45 cm long and placed in such a way that the axis of its pivot went through the two carbon arcs of the system to be studied. The arm was swung out to form an angle of 35°

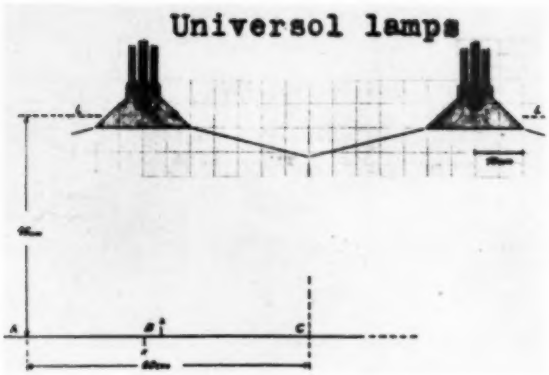


Fig. 7. Same as Fig. 6 b for the Universol lamp.

with the vertical (see *Fig. 9*). This angle is defined as the direction from the carbon-arc to the axis of a patient lying at the normal treatment distance. The P. E. C. with mask and filter was covered with a polished metal plate with a fixed aperture of suitable size, and owing to this arrangement the P. E. C. was only very slightly heated during the radiation.

When the measuring circuit had been closed, the P. E. C. was illuminated for 11—15 minutes before the recording was commenced, the P. E. C. after this preliminary period being »wearied». The recording itself

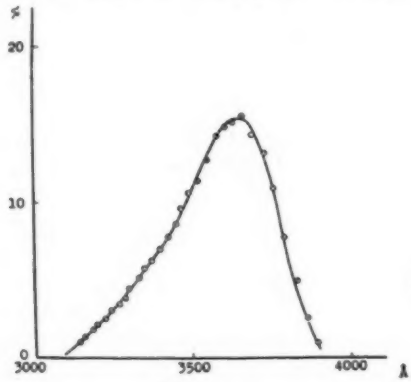


Fig. 8.

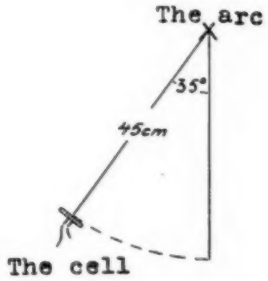
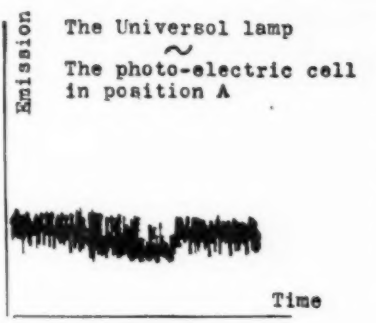


Fig. 9.

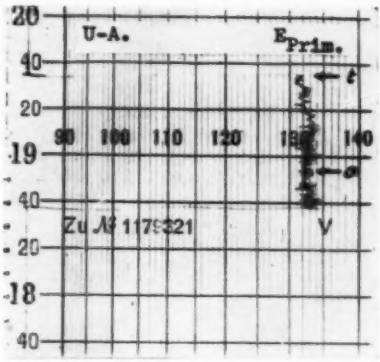
Fig. 8. Transmission of the filter used; abscissa: wavelength in Å. U., ordinate: transmission in per cent.

Fig. 9. Position of the photo-electric cell during the measurements.

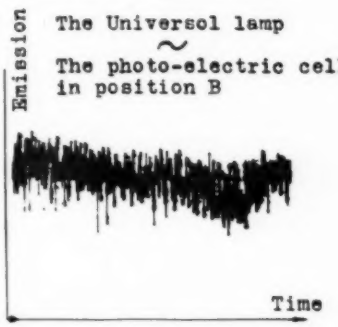
10 a.



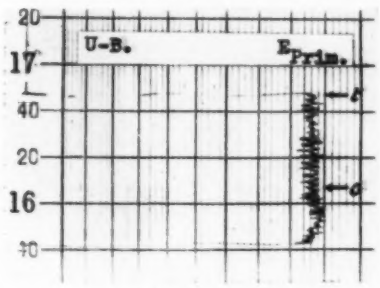
10 b.



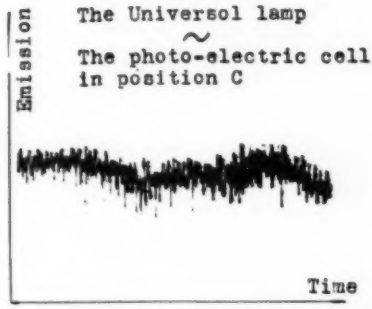
11 a.



11 b.



12 a.



12 b.

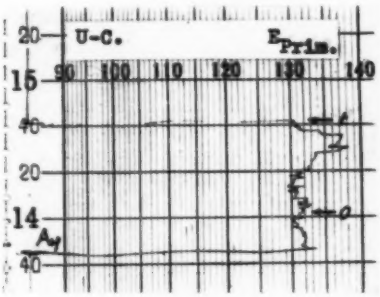


Fig. 10 a, 11 a, 12 a. Emission in ultra-violet A from the Universol lamp (plotted against time) measured for different parts of the patient: A head, B chest, C middle part. White Flame (»Schneeweiss») carbon.

Fig. 10 b, 11 b, 12 b. Variation of the primary tension of the transformer during the recordings shown in Fig. 10 a, 11 a and 12 a.

took about 40 minutes per experiment. The primary voltage of the transformer was recorded simultaneously by a self-recording voltmeter. Measurements were made with the P. E. C. in the positions A, B, and C (head, chest, middle part), see *Figs. 6 a and 7*. Results are shown for:

The Universol lamp with white flame-carbons (Schneeweiss, Siemens) in *Figs. 10 a and b*, *Figs. 11 a and b*, and *Figs. 12 a and b*, and for the Universol lamp with pure-carbons (Siemens A carbons) in *Fig. 13*.

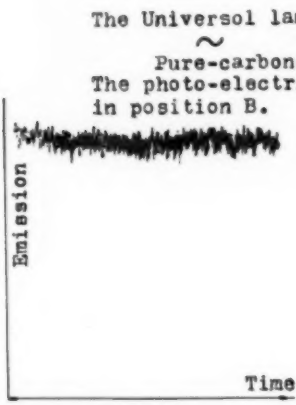


Fig. 13. Emission in ultra-violet A from the Universol lamp with pure carbon (Siemens A). Note the fine constancy. The small fluctuations in the curves given in Fig. 10 a, 11 a and 12 a are due to the lack of homogenity of the white flame carbons used.

In order to make a comparison with the magazine lamp mentioned above, similar measurements were made with the latter. In this were also used Schneeweiss carbons, but of Conradty's make — not Siemens' — in accordance with Dr Saugman's directions.

The results for the magazine lamp (Saugman) with flame-carbons are shown in *Figs. 14 a and 14 b*, *Figs. 15 a and 15 b*, and *Figs. 16 a and 16 b*.

When comparing the photo-currents in the emission curves in Figs. 10—16, it must be noted that during the measurements with the Universol lamp the P. E. C. was provided with an aperture of about 231 mm², while during the magazine lamp measurements the aperture area was only about 125 mm².

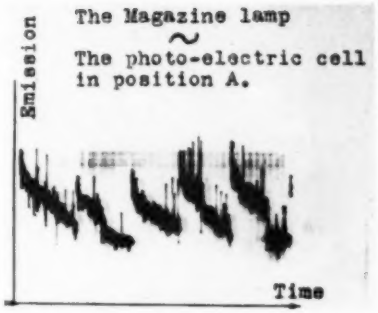
It will appear that there is a considerable difference between the sizes of the respective variations of the two lamp systems, but also that the said difference cannot be due to variations in the voltage of the mains. When looking at the emission curves for the magazine lamp, *Figs. 14—16*, the eye is caught especially by recurring falls interrupted by sudden rises. The explanation of these irregularities is as follows:

I. The plain stair-like falls are due to the successive burning away of the respective carbon pairs, as the regulating mechanism of the magazine lamp does not compensate for this.

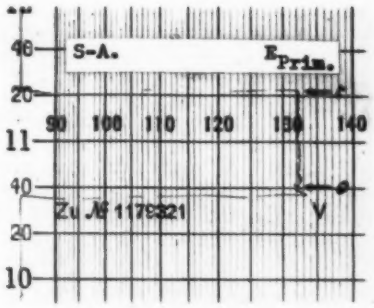
II. The reason why the curve rises time after time, after having reached a relative minimum, is the shifting of the carbon arc from a consumed pair of carbons to a new pair.

III. As can be seen, there is a rather considerable difference between the various maxima thus attained. This difference is dependent on the position of the new pair of carbons that is put in action. When the carbon pair is close to the P. E. C., the emission will be considerably greater than it is farther away; and here not only the altered distance asserts itself but

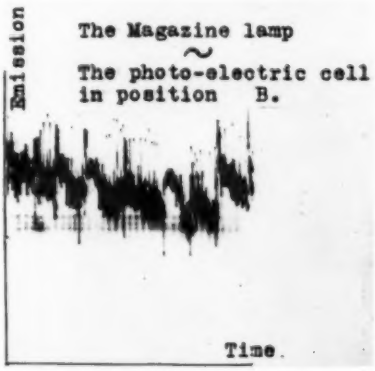
14 a.



14 b.



15 a.



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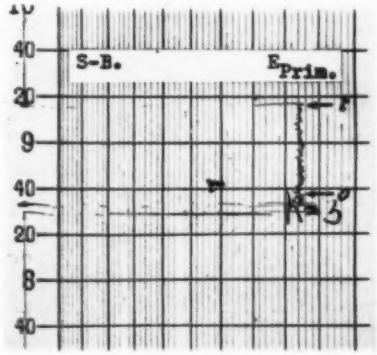
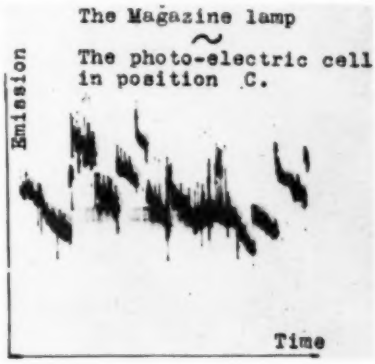


16 a.



16 b.

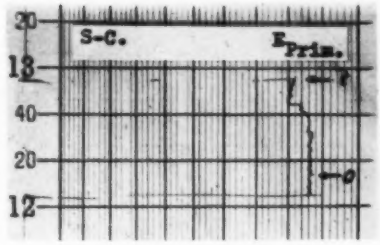
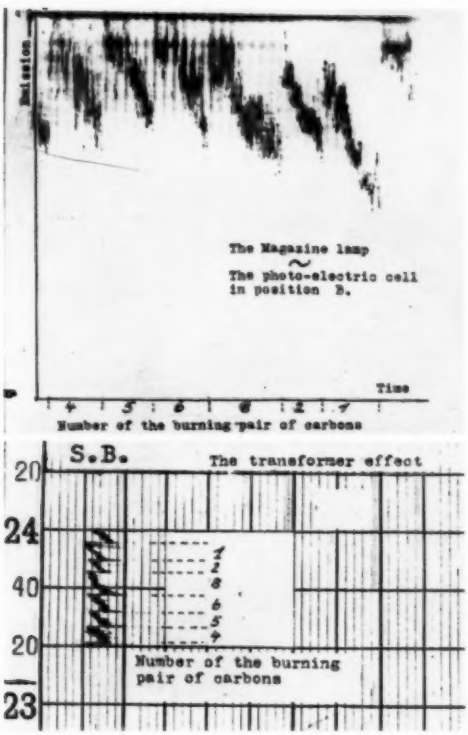


Fig. 14 a, 15 a, 16 a. Emission in ultra-violet A from the magazine lamp measured under similar conditions as in Fig. 10 a, 11 a and 12 a. Observe the great variations and sudden gaps.

Fig. 14 b, 15 b, 16 b. Variation of the primary tension of the transformer during the records shown in Fig. 14 a, 15 a and 16 a.



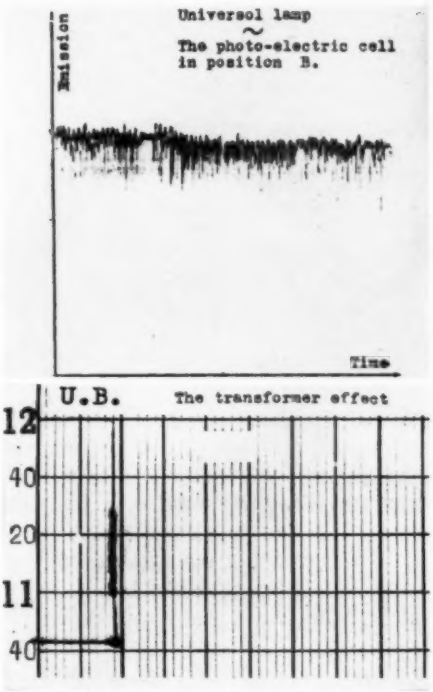
17 a.

17 b.

Fig. 17 a & b. Simultaneous records of emission in ultraviolet A and transformer effect for the magazine lamp. The great variations in emission and absorbed effect correspond exactly and they are due to the insufficient regulation system of this lamp.

also the circumstance that the current of the P. E. C. will vary with the angle of incidence of the received light. In the extreme cases where the angle of incidence of the rays to the P. E. C. is about 40°, the reduction may be about 15 per cent. *Fig. 17 a* shows one of these records of the emission from a magazine lamp, *Fig. 17 b* a simultaneously[1] obtained record of the primary effect of the transformer driving the magazine lamp concerned. The falls recorded for the primary effect correspond closely to the falls recorded in the photo-current curve. A set of corresponding records of the Universol lamp is appended for comparison. The records show how regularly and steadily this lamp works (*Figs. 18 a and b*).

[1] These experiments were made in November 1944.



18 a.

18 b.

Fig. 18 a & b. Simultaneous records of emission in ultraviolet A and transformer effect for the Universol lamp. These recordings show very good constancy.

The Radiation Curves.

Finally is shown the appearance of the light radiation curves for the two lamp types, the Universol lamp and the magazine lamp. The measurements were made by means of the apparatus previously mentioned. The results can be seen in *Fig. 5* and *Fig. 19.*

The curve points are defined as the mean values of 12 measuring series during which the P. E. C. was swung gradually from position 0° to position 90° and vice versa. In the case of the magazine lamp, each measuring series had to be completed quickly (in about 35 seconds) because the radiation decreased heavily as the carbons burned away. The difference in shape of the curves should be noted: it is, of course, due to the fact that the Universol lamp is provided with a protecting screen. The cross-lines indicated denote the maximum and minimum deflections in the measuring series upon which the plotting of the curves was based.

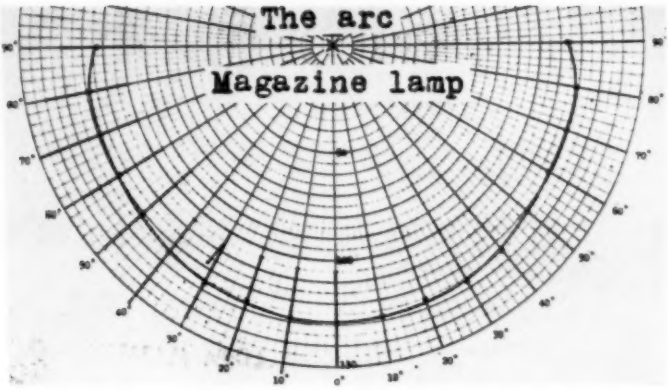


Fig. 19. Distribution of the ultra-violet A emission of the magazine lamp.

The big variations in the radiation of the magazine lamp were avoided by making the measurements a little after the shifting of the arc from one pair of carbons to the next, a comparatively steady period then having commenced. Even under such circumstances the difference in size of the light fluctuations is conspicuous.

Concluding Remarks. The Universol lamp works at a higher arc voltage than the magazine lamp. This may involve a possibility of a small difference in the efficiency, expressed in ultra-violet-lumen per watt, within certain wavelength limits. Only a more exact measuring technique can clear up this problem. But then, this difference is of interest only when both systems work continuously; if, on the other hand, there are

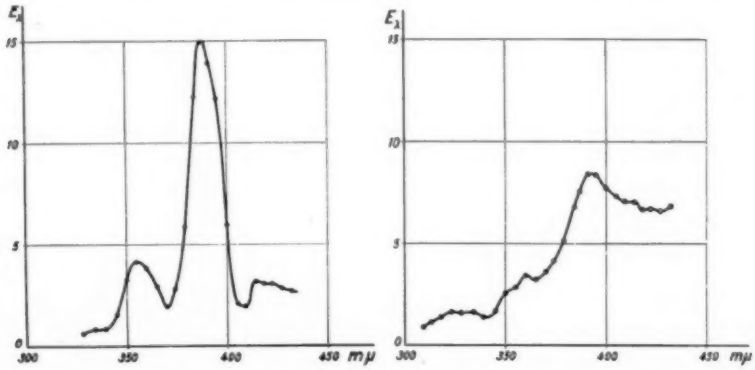


Fig. 20, 21. Intensity-wavelength distribution in ultraviolet A from the Universol lamp with pure carbons and white flame carbons respectively.

variations in the light emission from each individual pair of carbons of up to 40 per cent., as is the case in the magazine lamp, then a possible difference of the kind mentioned above is only of quite inferior importance.

In case a more exact measuring technique might prove it desirable to effect (minor) alterations with regard to the arc voltage and the angle of inclination of the carbons, the design of the Universol lamp will readily permit such alterations.

The Spectral Distribution of the Radiation from the Universol Lamp at the spot B is shown in *Figs. 20 and 21*, the lamp having burned pure-carbons (A-carbons) and Schneeweiss carbons respectively. It will appear from the curves that the radiant energy between 3 300 and 4 000 Å. U. is practically speaking identical in the two cases: but it must be mentioned that the energy consumed by the A-carbon lamp was 1 600 watts, as against 1 200 watts in the case of the Schneeweiss lamp.

When being run near its normal working point (about 51 volts, 25 amperes), the emission in ultra-violet A of the Universol lamp (with Schneeweiss carbons) exceeds that of the magazine lamp by more than 40 per cent., which should be taken into consideration when deciding the dosage.

SUMMARY

After a description of The Finsen Institute's new a. c. arc lamp for light treatment purposes follows a statement of the results of comparative measurements of the constancy of the ultra-violet A radiation from the above mentioned lamp and Dr Saugman's magazine lamp. The measurements prove that our expectations of attaining a considerably better constancy than that of the magazine lamp by employing the Ferraris principle for the regulation of the arc lamp were fully satisfied.

Per k. w. h. the emission is very nearly the same for the two types of lamp.

ZUSAMMENFASSUNG

Nach einer Beschreibung der neuen Universol-Lampe des Finseninstituts-Lampe zu Lichtbehandlungszwecken, werden die Ergebnisse einer vergleichenden Messung der Konstanz der Ultraviolett-A-Strahlung dieser Lampe und der Saugman'schen Magazin-Lampe festgestellt. Die Messungen erweisen, dass unsere Erwartung, durch Verwendung des Ferrari'schen Prinzips zur Regulierung der Bogenlampe eine bedeutend bessere Konstanz zu erzielen, als die der Magazin-Lampe, durchaus in Erfüllung gegangen ist.

Die Strahlung per Kilowattstunde ist bei den zwei Typen von Lampen fast ganz dieselbe.

RÉSUMÉ

Après une description de la nouvelle lampe à courant alternatif de l'Institut Finsen, l'auteur expose les résultats de mesures comparatives de la radiation ultra-violette A entre la lampe mentionnée ci-dessus et la lampe à magasin du Dr SAUGMAN. Les mesures démontrent que la prévision d'une constance supérieure à celle de la lampe à magasin en utilisant le principe de Ferrari comme régulateur de la lampe à arc était parfaitement fondée.

Pour les deux types de lampe, l'émission est à peu près identique par kwh.

FROM THE DEPARTMENT OF DIAGNOSTIC ROENTGENOLOGY OF THE KAROLINSKA SJUKHUSET, STOCKHOLM (HEAD: PROFESSOR Å. ÅKERLUND)

THE ROENTGEN APPEARANCE OF THE ANTERIOR WALL OF THE SULCUS SIGMOIDEUS[1]

by

Eric Selander

In lateral views of the cell system of the ear in RUNSTRÖM's projections I and II, for instance, or in the projections proposed by SCHÜLLER, LANGE, SONNENKALB *et al.* the anterior sinusal wall and the posterior border of the pyramid, as a rule, coincide. In some instances, however, *two* convex contours curving more or less in a forward direction, are visualized at the level of this area (Fig. 1). According to MAYER the anterior contour is due to the anterior wall of the sigmoid sinus which penetrates deep into the basis of the pyramid, whereas the undermined posterior border of the pyramid is supposed to account for the posterior contour.

As regards the underlying anatomic reasons of these double contours otoroentgenologists, as far as the author knows, still believe that MAYER's view holds good. At any rate, no other details but the two mentioned ones have so far been made reponsible for the appearance of these contours.

A study of the films of 200 cases revealed that in 54 of these, *i. e.* in 25 per cent of the cases, double contours were present. A careful stereoscopic examination, however, yielded the sursprising result that the anterior contour was situated medial to the posterior one in no less than 52 of these 54 cases. The correctness of this observation was easily checked by measuring the distance between the two contours in the different projections. In orthoscopic views, in projection 3° from behind, for instance, this distance appears, as is known, greater.

If MAYER's view were correct the anterior wall of the sinus would be expected to be situated medial to the posterior border of the pyramid, an assumption which is hardly acceptable. In two cases only was the anterior contour situated laterally, *i. e.* its position corresponded to that

[1] Submitted for publication Aug. 2, 1945.

Fig. 1. RUNSTRÖM's projection II showing double contours in the area of the sinus. For the examination of the stereoroentgenograms reported a prismatic field glass with additional frontal lenses (LYSHOLM) is most helpful. By means of this device an orthoscopic stereoscopic view is obtained.

assumed by MAYER. In the majority of the cases presenting double contours, therefore, the posterior contour is sure to correspond to the wall of the sinus. The explanation for the anterior contour has so far not been determined.

Hoping that one of the various shapes which the pyramid is prone to show, would furnish an explanation of this contour about 30 temporal bones were studied. Some of these presented contiguous to the posterior border of the pyramid an impression on the posterior surface of the pyramid (Fig. 2). Medially, this impression was bordered by a bone eminence which was more or less pronounced and extended laterally cranialward up to the sino-dural angle; below the medial part of this eminence the apertura interna canaliculi vestibuli (formerly termed apertura externa aquaeductus vestibuli) was visualized. In instances in which this eminence was strongly pronounced, the shape of the impression was, to a certain extent, similar to the sinusal groove.

The roentgen observation of such a preparation in RUNSTRÖM's projection II shows typical double contours the anterior one of which is situated medially, a picture which is analogous to those discussed in this paper (Fig. 3). After placing a metal wire along the anterior sinusal wall, and another along the bone eminence and the edge of the sino-dural angle (Fig. 4), the preparation was reexamined (Fig. 5). This examination revealed that the posterior contour was due to the

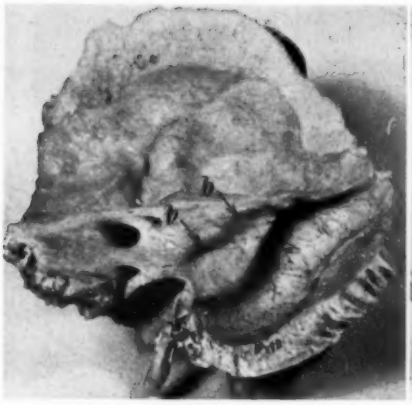


Fig. 2.

Fig. 4.

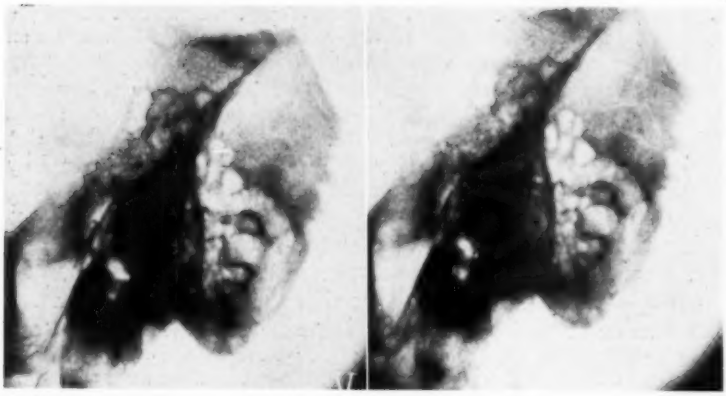


Fig. 3.

Fig. 2. Temporal bone with pronounced impression and bone eminence (b) on the posterior surface of the pyramid.
Fig. 3. Roentgenograms of the preparation illustrated in Fig. 2. RUNSTRÖM's projection II.
Fig. 4. Metal wire placed along the bone eminence — sino-dural angle, and anterior wall of the sinus.

anterior wall of the sinus. The anterior contour corresponded to the bone eminence on the posterior surface of the pyramid, an observation which has so far escaped attention. The middle portion of the bone eminence is, as a rule, situated at a distance of approximately 1 cm

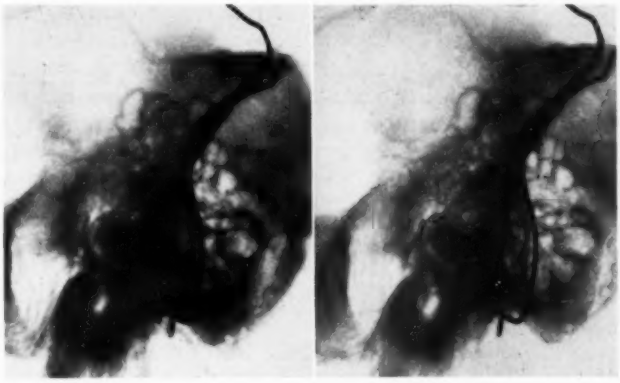


Fig. 5. Roentgenogram of Fig. 4. RUNSTRÖM's projection II.

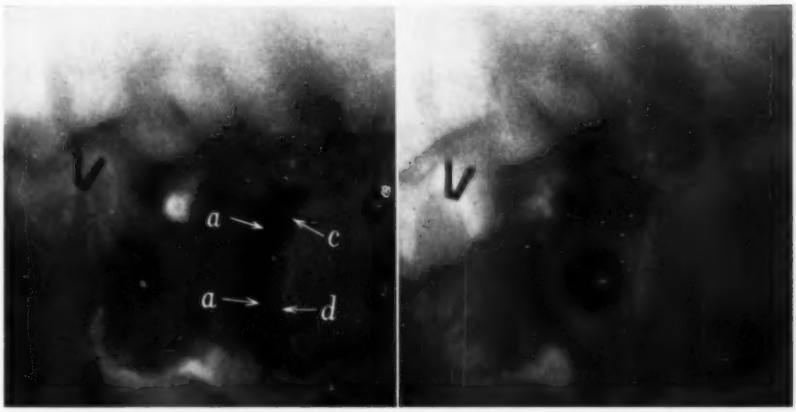


Fig. 6. Case in which the border of the pyramid (= d) is visualized. a = the anterior wall of the sinus, c = sino-dural angle.

medial to the posterior border of the pyramid, immediately behind the mass of the labyrinth. The fact that this portion is situated closely to the solid mass of the labyrinth explains why roentgen evidence of the bone eminence in the presence of moderate pneumatization partly simulates to be a border-line between an anterior area of greater density (the labyrinthine mass) and a posterior less dense area (pneumatization in front and medial to the sinus).

In the two instances in which the anterior contour was situated laterally, it corresponded to the wall of the sinus. The posterior one was due to the border of the pyramid which had the appearance of a thin, band-like shadow extending parallel to the sinus line backwards. This shadow did not present any linear posterior margin (Fig. 6). The sinodural angle may produce a similar picture if the upper bend of the sinus curves in forward direction. This was the case in the preparation reproduced in the Figs. 3 and 5, as well as in the case shown in Fig. 6. Thus, in solitary cases three contours may occur which, interpreted one by one and beginning with the foremost one, correspond to the bone eminence, the anterior wall of the sinus, and the posterior border of the pyramid.

As regards the changes in the aspect of the sinus line and the posterior border of the pyramid in the presence of a perisinuous abscess roentgen literature is filled with more or less conflicting views. WELIN gives a survey of the existing theories in Chap. 6 d of his thesis. This difference in opinion is in the first place, most likely, due to misinterpretation of the double contours which may also frequently have led to the incorrect diagnosis of forward displacement of the sinus. Definite interpretation of the roentgen details discussed, necessitates, therefore, correct determination of the position of the contours in relation to one another in the frontal plane. For this purpose stereoscopic roentgenographic examination will be a most valuable help.

SUMMARY

In lateral views of the cell system of the ear two convex contours curving more or less in forward direction were visualized in the area of the sinus in about 25 per cent of the author's cases. The author furnishes evidence that in nearly all cases the anterior contour is due to a bone eminence on the posterior surface of the pyramid which is particularly pronounced in cases of this type, and that the posterior contour is formed by the anterior wall of the sinus. The posterior border of the pyramid comparatively seldom produces a contour of its own, *i. e.* a possible third contour. For the reliable analysis of these details stereoscopic roentgenographic examination is indispensible.

ZUSAMMENFASSUNG

Im Seitenbilde des Zellensystems des Ohres treten bei ungefähr $^1/_4$ der Fälle im Sinusgebiete zwei nach vorn mehr oder weniger konvexe Konturen hervor. Verf. beweist, dass die vordere dieser Konturen fast immer durch einen bei diesen Fällen besonders stark hervortretenden Knochenwall an der Rückseite der Pyramide bedingt ist, während die hintere Kontur der vorderen Sinuswand entspricht. Der hintere Rand der Pyramide bildet verhältnismässig selten eine eigene (eventuelle dritte) Kontur. Zur Analyse dieser Finzelheiten ist die Stereoskopie unumgänglich notwendig.

RÉSUMÉ

Sur les images latérales du système cellulaire de l'oreille, on voit apparaître dans un quart des cas, dans la région du sinus, deux contours plus ou moins convexes antérieurement. L'auteur démontre que le plus avancé de ces contours résulte presque régulièrement d'une éminence osseuse particulièrement développé sur la partie postérieure de la pyramide, tandis que le contour postérieur correspond à la paroi antérieure du sinus. L'arête postérieure de la pyramide forme assez rarement un troisième contour qui lui soit propre. Pour l'analyse de ces détails, la stéréoscopie est indispensable.

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FROM THE DEPARTMENT OF ROENTGEN DIAGNOSTICS OF KAROLINSKA SJUKHUSET, STOCKHOLM (CHIEF: PROFESSOR Å. ÅKERLUND)

PERCUTANEOUS PUNCTURE OF RENAL CYSTS AND TUMORS[1]

by

Knut Lindblom

Too often the differential diagnosis between renal cysts and tumors cannot be made by routine methods of clinical and roentgenological examinations. The usual case history is: an elderly patient with an increased blood sedimentation has roentgenological signs of an expansive focus in one kidney, probably a cyst but possibly a hypernephroma. The only way of getting a diagnosis is an operation, but at that age an operations means considerable risks. Several cases operated upon for this purpose died of pneumonia or other complications.

Roentgenologically, two different ways may lead to a correct diagnosis. The one way is aortography according to DOS SANTOS; the other is a percutaneous puncture of the expansive focus with or without injection of a contrast medium. In comparison to an operation these procedures are harmless. At the Karolinska sjukhuset aortography was performed in a case of renal infarction but was not used for diagnosis of cysts or tumors of the kidney. The experiences of arteriography on anatomical specimens have learned that the distinction between hypovascular tumors and cysts is difficult; in both cases the vessels of the false or true capsule overlay and disturb the study of structures of the focus itself. On the other hand a percutaneous puncture of the focus proved to be easy when localized by roentgenography and fluoroscopy.

In the literature punctures of cysts are mentioned, e. g. by FISH. The use of the method does not seem to be exhaustive, and FISH in 1939 gave a negative answer on the question: »Can a positive preoperative diagnosis of solitary cysts ever be made?» A recent paper by WHEELER on the use of aspirating needle in diagnosis of solitary cysts is not available.

[1] Submitted for publication, May 3, 1945.

Technique

The patient is placed in a prone position. The renal pelvis is visualized by excretory or retrograde filling. During fluoroscopy a centrimetre-scale of metal is fixed on the back of the patient longitudinal to the body right above the expansive focus of the kidney. Frontal and lateral views are taken. On the lateral view the puncture depth is determined by the aid of the picture of the scale. The depth is marked on the puncture needle by a peang, which serves as a stop. The needle is entered through the skin and the muscles, strict vertically right above the expansive focus. During fluoroscopy the patient is trained to hold his breath at a stage where the expansive focus is right below the needle. At that stage the needle is entered to its full length. If the focus is a serous cyst it begins to empty immediately. If diodrast or another contrast medium is injected it spreads in a cyst cavity or in a tumor tissue, which of the two the following roentgenograms will tell.

In order to avoid a puncture of the pleural cavity the stomach of the patient must be elevated by pillows. Theretoo, the pillows cause a stasis in the pelvis and thus facilitate the localization.

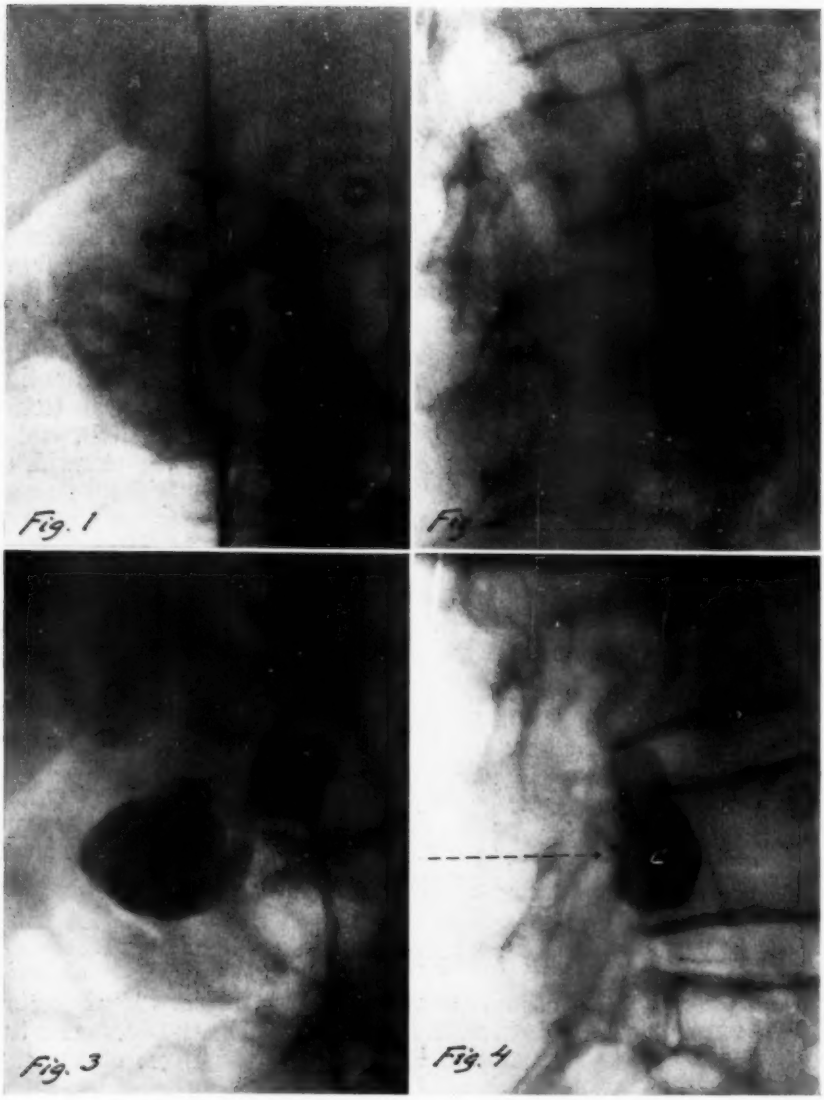
Material

Since the beginning of the method in July 1944, 6 cases were examined in this way.[1] One case had an hypernephroma and the others had solitary cysts. The cysts belonged to the inferior part of the kidney. The hypernephroma was situated above the pelvis. The location of the two kinds of lesions was thus typical. The age of the patients was 59—71 in the cyst cases and 41 in the hypernephroma case. The blood sedimentation was increased to 30—100 mm/l hour in three of the cyst cases and 50 mm/l hour in the hypernephroma case. In the cyst cases the clinical symptoms were back pains or palpable tumor and in one a longstanding fever. The hypernephroma case had a recurrent cystitis. No case showed signs of urinary hemorrhage.

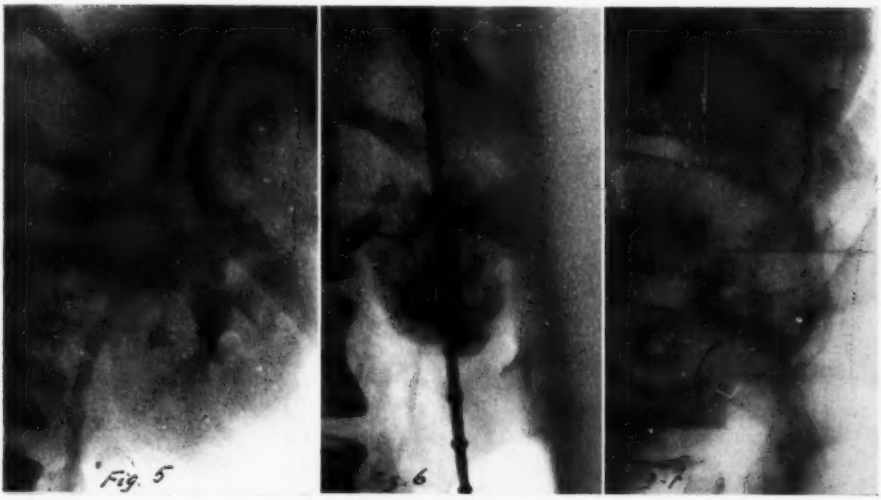
Roentgenographic findings

In all cases the puncture of the expansive foci was followed by injection of 2—7 ccm of 35 % diodrast with some novocain. In the cyst cases the roentgenograms showed cysts of $2^1/_2$, 3, $3^1/_2$, $4^1/_2$ and 10 cm of diameter respectively. They were well defined and spheric with more or less trace-

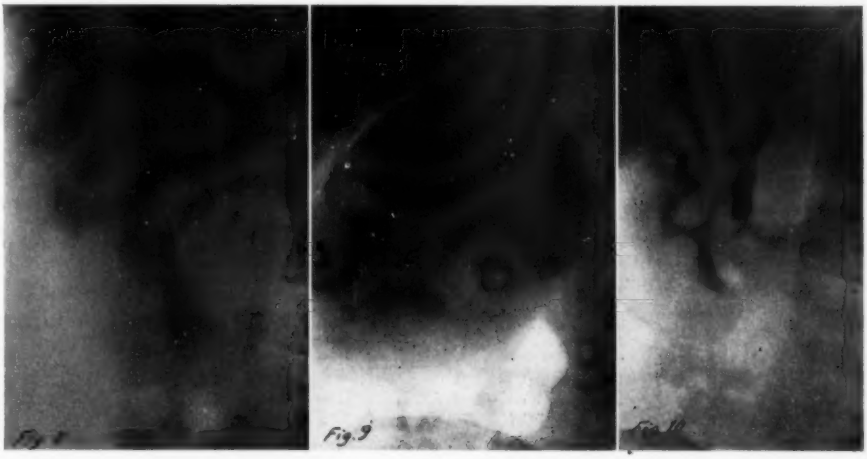
[1] Since the submission for publication 4 additional cases were punctured. The results were cysts in 3 cases and hypernehroma in the remaining case. The one cyst belonged to the upper pole of the kidney. The hypernephroma was situated behind the pelvis; this case had urinary hemorrhages but a blood sedimentation of 5 mm/1 hour.



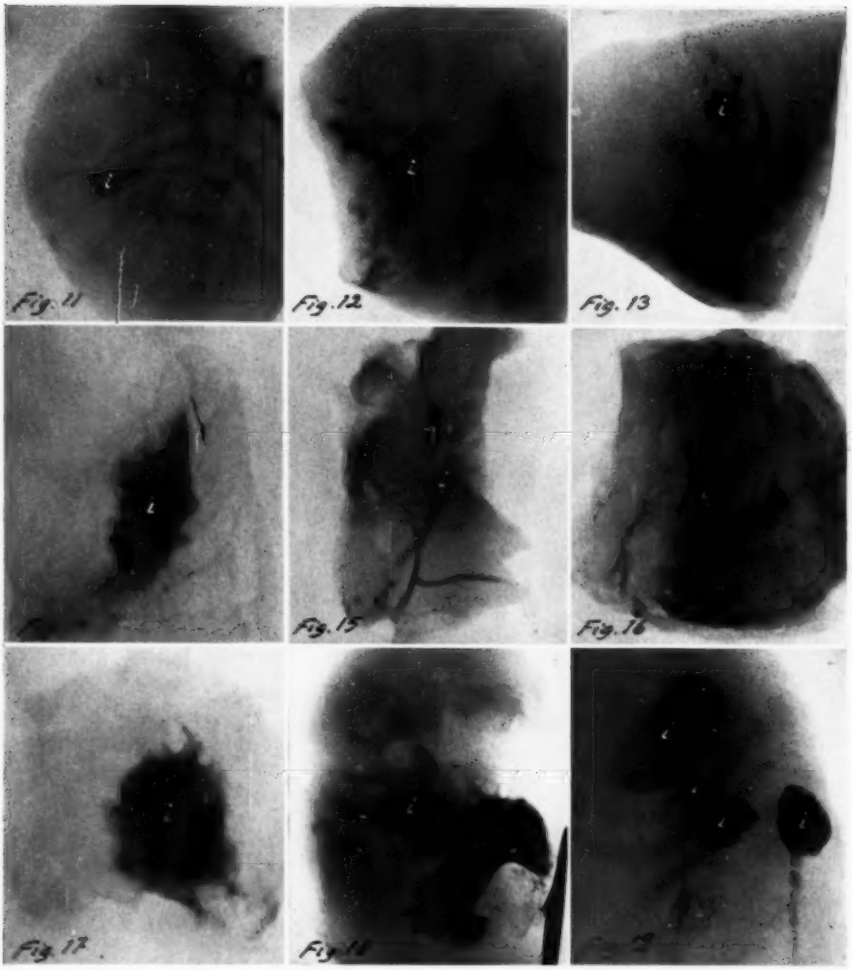
Figs. 1—4. Roentgenograms of the right kidney before and after percutaneous puncture and injection into a cyst (c). The punctured line marks the course of the needle.



Figs. 5—7. Roentgenograms of the left kidney before and after percutaneous puncture and injection into a hypernephroma (h).



Figs. 8—10. Roentgenograms of the right kidney before percutaneous puncture of a great cyst (Fig. 8), after puncture and injection into the cyst (Fig. 9), and after disappearing of the cyst (See text) (Fig. 10).



Figs. 11—17. Roentgenograms of kidney, spleen, liver, lung, heart muscle, psoas muscle, and perirenal fat, punctured and injected with diodrast (at *i*). Note the different forms of spreading.

Figs. 18—19. Roentgenograms of renal papilloma and pararenal fibrolipoma, at *i* injected with diodrast.

able partitions (Figs. 1—4). The case of the great cyst had a palpable nodule, looked upon as a tumor, which proved to be a ventral bubble of the main cyst. The contents of the cysts were serous. No tumor-like defects were seen in the cysts.

In the hypernephroma case the diodrast spread interstitially between the lobules and gave a view of the structure of the tumor (Fig. 5—7). A nodule of the tumor projected into a renal papilla. The tumor showed minute calcifications. All details of this roentgenographic appearance were verified at the postoperative examination of the specimen.

Complications

At the injection 3 patients felt a dull pain for a short while. In 3 cases the procedure was followed by $^1/_2$ degree of increased temperature for 1—2 days. Five days after the puncture the case of the great cyst had signs of a bronchitis, and some days later pains appeared on the punctured side where an increased tumor was palpable. After a fortnight the acute symptoms had gone, and three months later an excretory urography showed an almost normal pyelogram (Figs. 8—10). The course was interpreted as follows: the puncture favoured a secondary infection or rupture of the cyst after which the cyst disappeared.

Anatomic studies

The first puncture was preceded by injections of diodrast in normal anatomic specimens: kidneys, spleens, livers, lungs, heart muscles, psoas muscles, and perirenal fat. The roentgenographic appearance is illustrated in Figs. 11—17. In kidneys, spleens, and livers the contrast medium formed a small spot of homogeneous structure and diffuse outlines, after which a filling of vessels was obtained. In lungs, muscles and fat the contrast medium spread interstitially, forming more or less characteristic structures. The knowledge of these injection roentgenograms of normal tissues of anatomic specimens ought to be of great value for the interpretation of injection roentgenograms in vivo, though there was no use of it in this material.

Tumors were represented by the hypernephroma case only. In order to widen the knowledge of injection structures in other tumors the specimens of one renal papilloma and one pararenal fibrolipoma were injected. The roentgenograms are illustrated in Figs. 18—19. The papilloma showed irregular structures and filling of vessels. In the fibrolipoma the diodrast spread diffusely round the point of injection and along the injection canal.

SUMMARY

By the aid of fluoroscopy and roentgenography expansive foci in kidneys were punctured and injected with diodrast. The method is valuable in the diagnosis of renal cysts and tumors.

ZUSAMMENFASSUNG

Mit Hilfe von Durchleuchtung und Röntgenaufnahme wurden expansive Nierenherde punktiert und Diodrast eingespritzt. Die Methode ist wertvoll zur Diagnose von renalen Zysten und Tumoren.

RÉSUMÉ

A l'aide de la radioscopie et de la radiographie, on a ponctionné des foyers expansifs dans les reins et on y a injecté du diodraste. La méthode a de la valeur pour le diagnostic différentiel entre les tumeurs et les kystes rénaux.

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ROENTGENOLOGIC SKELETAL CHANGES IN MYELOMA IN CHILDHOOD[1]

(Platyspondylia generalisata myelomatosa)

by

Gösta Jansson, Docent

Multiple myeloma or myelomatosis is generally considered a disease occurring in persons of advanced age. This conception is so firmly rooted that prominent bone pathologists such as GESCHIKTER and COPELAND, when making reports on the cardinal symptoms of the disease, stress the fact that myeloma occurs particularly in individuals of old age. It is said to be unknown to many that myelomatosis may occur also in childhood — it was so to me, anyhow. This lack of knowledge is, however explicable as 8 cases only of child-myelomatosis have been published in the world literature, according to SCHAFFA, 1939. Manuals of medicine give the age of 27 as being the lowest for the appearance of myeloma. As I have had the opportunity of examining roentgenologically a child suffering from myeloma and showing spinal changes of the type known as *platyspondylia* I consider a report on the case called for.

The patient, a boy, aged 9, sickened in the spring of 1942 with recurrent fever and pains in his back followed by progressive anemia. In June of the same year, the hemoglobin content was 38 per cent and the sedimentation reaction of the blood 78 millimetres. He was treated at a war-hospital from the beginning of September to the end of December. The case was taken to be a renal disease as the urine often contained granulated cylinders in large quantities, leucocytes and solitary red blood corpuscles. The patient was transferred to the Urologic Department of the Surgical Clinic of the University, Helsingfors, on December 12th 1942. On admission he was very much reduced, almost cachectic, very pale, and complained of pain attacks, in his back and his legs. The transport to the roentgen department caused him severe pains and particularly when he was placed in a position for photography. He cried out if one tried to make him sit up in bed. There was now nothing to confirm a disease of the kidneys as the urine was free from albumin all the time, no granulated cylinders were found, solitary leucocytes, only, were noticed. Grave anemia was present. The blood picture showed, on January

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1st 1943, hemoglobin 22 per cent, erythrocytes 1,370,000, leucocytes 4,300, neutrophiles 20 per cent, lymphocytes 75 per cent, myelocytes 3.5 per cent. Notwithstanding repeated blood transfusions the anemia increased. On February 2nd 1943 (a few days before death) the number of red blood cells had decreased to 870,000 and the hemoglobin contents to 14 per cent.

The roentgen examination of the skeleton revealed extensive changes. The pelvic bones and the upper part of both femurs show multiple large and small, cyst-like pounched out areas of destruction. (Fig. 1, 2.) There are similar foci in the areas af the knee joints and in the bones of the shoulder joints. (Fig. 3, 4.) Nests are, contrarywise, completely absent from the skull and the ribs in which changes are frequently found in myeloma in adults. Sella turcica was normal. The lateral pictures of the spine show surprising findings. All the vertebrae have collapsed forming thin plates, some of them of biconcave configurations. The intervertebral discs are higher than normally, with a biconvex shape. The vertebral bodies are diffusely decalcified and do not show any cyst-like, demarcated foci as in the other parts of the skeleton. (Fig. 5.) A generalized platyspondylia was present, due to a diffuse malacia of the vertebrae.

The roentgenological diagnosis was difficult to make in this case, similarly the clinical diagnosis, especially as the patient was admitted into a urologic ward filled with sick soldiers. My lack of knowledge, as regards myeloma in childhood, made it easier, in a way, to make a diagnosis but it was a probability diagnosis only, which, however, proved to be wrong. The pictures included here resemble completely those of the Schüller-Christian disease, lipoidgranulomatosis in children. And as HELLNER, in his excellent work on the roentgendiagnostics of bone tumours, when speaking of lipoidgranulomatosis presents a picture of the spine of the same appearance as this one, morbus Schüller-Christian seemed quite probable although exophthalmus and diabetes insipidus were lacking. As known, one or two of the three cardinal symptoms in Schüller-Christian may be absent. An increased calcium or cholesterin value in the blood was found which supported the diagnosis. (The difficult differential diagnosis as regards disseminated cancer metastases was eliminated on account of the age of the patient.) But even if I had reckoned with a myeloma, the differential diagnosis between myeloma and Schüller-Christian would have been impossible to make solely on the basis of the roentgen pictures. HELLNER, the prominent bone pathologist, published a case in which he could not differ between »Schüller-Christiansche Krankheit oder jugendliches Myelom», as the title of his paper runs. BACH and MIDDLETON have observed diabetes insipidus in a case of myeloma which is explicable if the myeloma interests the hypophysis region. The urine was not, on account of reasons mentioned, examined for Bence-Jones protein, an examination which would not, however, have helped us in our difficulties. This reaction is often negative in myeloma. Positive reaction may be obtained, excepting in myeloma, in a number of other diseases as well, such as osteomalacy, tumor metastases, ostitis fibrosa generalisata, chloroma, lymphatic and

Fig 1.

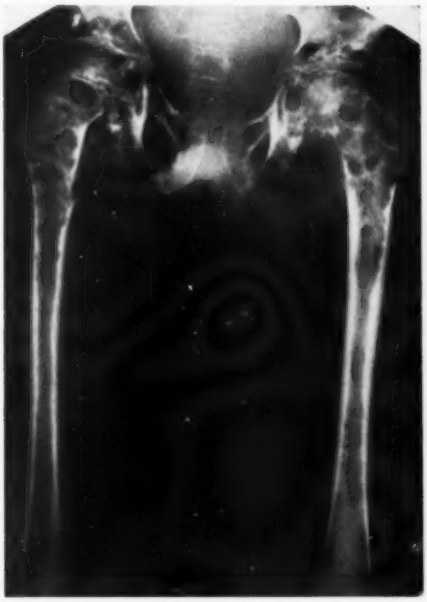

Fig. 2.

myelotic leuchemia and tub. spondylitis. The discovery of the roentgenological skeleton changes may, however, suddenly make it clear whether myeloma or Schüller-Christian is present but the sternal punction is decisive. An examination of the sternal puncture gives us information also of the type of cell which predominates the myelomatosis. NAEGELI differs between myelocytic, myeloblastic, lymphocytic, plasmacellic, erythroblastic and mixed-cellic myeloma. A test was made with sternal punction but it was not successful on account of the sternum having changed into one soft mass. The presence of hyperproteinemia and hyperglobulinemia support the diagnosis »myeloma».

The correct diagnosis was not made in vivo but the fact that the greatest number of cases published were diagnosed at obduction is a consolation to me. From a therapeutical point of view the myeloma diagnosis would not have been of decisive importance. The disease rapidly leads to death in young people while it may progress rather slowly in adults. There are no effective therapeutics.

The patient died of bronchopneumonia on February 14th 1943. At obduction a lymphocytic myelomatosis was stated. P. A. D.: Hyper-

Fig. 3. Fig. 4. Fig. 5.

plasia aleukaemica lymphatica medullae ossium, hepatis, lienis et renum. Destructio ossium praesertim vertebrarum. Calcificatio tubulorum renum.

The myelomatous process had thus not only affected the skeleton but infiltrated most of the parenchymal organs. The diffuse infiltration of the vertebrae had led to osteoporosis and collapse of the same. (Fig. 6.)

This platyspondylia was an interesting and surprising observation. The conception platyspondylia seems to be much discussed in the literature. The name is derived from the Greek word *platys* meaning broad. The diagnosis platyspondylia was originally used for those cases in which a congenital anomaly in the form of increased breadth, occasionally combined with hour-glass shaped vertebrae, was present. Height, content of calcium and structure were generally normal. Platyspondylia includes nowadays all cases in which the height is decreased but the breadth as a rule normal. To this group belong the acquired platyspondylias in which the vertebrae, on account of a malacy with a varying etiology, have collapsed into thin plates. It is quite understandable that systemic

diseases which involve the bone marrow diffusely with osteoporosis cause a collapse of the vertebrae. ZANDER has described a case of platyspondylia in osteogenesis imperfecta tarda in Acta Radiologica Vol. XXI. Among systemic diseases producing the above mentioned changes in the spine the Schüller-Christian disease (lipoidgranulomatosis) is mentioned among others, but the fact that myelomatosis may give rise to a platyspondylia is not mentioned.

The clinical picture of the disease is dominated from the very beginning by pains in the bones and, if the spine is affected as well, by pains, especially around the small of the back. This rheumatic state may last for months whereafter the pains increase and appear as attacks with calm periods in between. The patients call out if someone happens to push against the bed even, not to mention the intense suffering caused by removal or turning in bed. Sneezing and coughing may cause attacks of pain. Anemia develops simultaneously on account of generalized process of the bone-marrow. This anemia may reach excessive stages. Blood changes may be noticed at an early stage before roentgenological changes in the skeleton have been stated. This is no doubt due to the myelomatosis being more diffuse in the beginning causing but a slight general decalcification of the bone which may escape notice. Later granuloma- or tumour-like collections of myeloma cells arise causing rounded cyst-like defects in the bone system. If the destruction of the skeleton continues varying symptoms arise on account of the position of the foci, and sometimes spontaneous fractures are noticed. If the spine is affected too, severe root-pains arise. Some patients have had abdominal symptoms which have led to appendectomia. Nests in the skull bones may, if they spread over into the menings, cause meningitical symptoms. Diffuse myelomatosis of the heart muscle may lead to myocardic injury and insufficiency of the heart. Sometimes symptoms arising in the kidneys dominate at the onset of the disease, as in my case. The kidney affection has not yet been explained definitely. Some authors believe the elimination of Bence-Jones protein to be the cause thereof. I should like to suggest that the enormous excretion of calcium may irritate the kidneys and explain the kidney symptoms. The disease in the bone-marrow causes, as known, a decalcification of the whole skeleton and even if a part of the calcium is layered in the internal organs the greater part is, however, eliminated from the body by way of the kidneys. In the post-mortem papers of some cases, and of my own case, it is stated that calciferous deposits were present in the tubuli and in some cases there was calcareous gravel in the pelvis. Decalcification of the skeleton may be much greater than what might be believed in some cases from the extent of the roentgenologic changes. A diffuse, slight myelomatosis of the bones does not appear clearly in the roentgen pictures.

In Acta Radiologica Vol. XI, 1930, JACOBI gives an account of a case of myelomatous platyspondylia in a girl of 8 years. The term platyspondylia in its wider meaning, was, however, not used at that time. The patient was admitted into hospital with the diagnosis spondylitis. The spine only was photographed roentgenologically and there is no roentgen diagnosis. At the post-mortem examination the diagnosis »myelomatosis» was made. Blood tests are not mentioned.

In 1932, ZÄH describes the first authentic case in Germany of myeloma in children and according to him it is the third case in the world literature. The case concerns a boy of 6 years, who sickened with symptoms leading to the diagnosis spondylitis tuberculosa cervicalis. The cervical vertebrae only were examined roentgenologically whereby the 3, 4 and 5 cervical vertebrae were found to be affected. Later a collapse of the 5th cervical vertebra caused gibbozity formation and neurologic symptoms in the form of paralysis of the upper extremities. Urine and blood findings are missing. Post-mortem examination revealed a myelomatosis in the cervical and upper thoracal vertebrae. Myeloblast-myeloma was present.

In 1934, SLAVENS of the Mayo Clinic, reports a case of multiple myeloma in a boy of 4 years of age. The clinical picture is dominated by abdominal pains which led to appendectomia. Roentgenologically a destruction was observed of some of the lumbal vertebrae and later of the thoracal vertebrae and foci in the skull bones. Moderate anemia. Bence-Jones protein reaction negative. The diagnosis was made in vivo by specimen from the scull foci. P. A. D. was multiple myeloma of myeloblastic type in the scull, vertebrae, os ileum and right femur. Myeloma masses were found even in the spleen, liver and abdominal lymphatic glands.

LAURENTIUS mentions, in 1938, a boy of $6^1/_2$ years who had sickened with pains in the right femur and gradually increasing stiffness in the back, pains in the head and the neck and a distinct stiffness in the neck. The disease was first considered to be rheumatism. Not until two and a half months later changes in the skeleton were stated roentgenologically. Small nests were found in the skull bones, in the right femur, and in the left radius. A notable symptom, from roentgenological point of view, was, in this case, the presence of periostal layers which are not, as a rule, noticed in myelomatous nests in the bones. The lumbal liquor showed pathologic changes and it was supposed that the skull nests had affected the menings causing meningitic symptoms. Bence-Jones protein reaction in the urine was negative. The blood picture was as follows: erythrocytes 2,900,000, haemoglobin 78 per cent, leucocytes 2,000. The myeloblast-myeloma diagnosis was made by sternal puncture.

The most recent case, published in 1939, is by SCHAFFA. (The war-

time literature has not been available to the author.) A girl of 12 years was admitted into the children's clinic at Brünn with the diagnosis appendicitis. An acute myocardic affection and liver stasis was, however, stated in the hospital. After observation of 2 month's pains in the back and the extremities arose and a spontaneous fracture of the ribs. On that account a roentgen examination of the skeleton was undertaken and multiple nests in the skull were observed, femora and some thoracal vertebrae were disclosed. Sternal puncture revealed that myeloblast-myeloma was present. Severe anemia developed. The blood values were shortly before death: erythrocytes 820,000, haemoglobin 10 per cent. The patient died of broncho-pneumonia. P. A. D.: Myeloma multiplex ossium. Anemia. Bronchopneumonia. Lipomatosis myocardii. Pyelonephritis. Nephrolithiasis (kidney gravel). Infiltration of the myeloma cells were noticed in the myocardium, the liver, the kidneys and the spleen.

The question is far from clear whether the multiple myeloma or the myelomatosis is a system disease or a metastasizing form of tumour, developing from the bone marrow. Adherors of the tumour theory point out, as a proof, the cases of solitary myeloma with long duration that have been observed. BICHEL and KIRKETERP have lately investigated critically all cases published of solitary myeloma. The authors consider that two cases only of the 27 published in the literature may be said to be conclusive. They also report two of their own cases of seemingly solitary myelomas but an examination of the bone marrow proved the presence of generalized myelomatosis. If a trial to establish a roentgenological aspect of the question is made the resemblance between the roentgenological skeleton changes in myelomatosis and lipoidgranulomatosis in children gives rise to speculations. As I have earlier had the opportunity of examining roentgenologically a case of Schüller-Christian, and lately a case of myeloma in a child (extremely rare diseases in children), I was struck by the close resemblance of the roentgen pictures. The lipoidgranulomatosis is due to metabolism disturbances leading to deposits of lipoid layers in the tissues. The lipoids are placed in so called Xanthom cells, and around them a granulation tissue of different exudation cells arises, a lipoid granuloma develops. They involve the bones and give rise to the roentgenological skeleton changes. A diffuse infiltration with typical cell elements of the disease occurs partly in the bones and partly in the parenchymatous organs. In myeloma we also have a granulomalike collection and diffuse infiltration of myeloma cells in the bone system or in the parenchymatous organs. Lipoidgranulomatosis is a systemic disease interesting the whole body. One might be inclined to consider the myelomatosis a systemic disease too, developing from the bone marrow. The characteristic, sharply rounded defects which appear

to be pounched out, speak against an infiltrative aggression resembling tumour metastasis but speak for expansively growing collections of cell masses.

The etiology of myeloma appears to be unknown. We do not know of any effective therapeutics. In the slowly progressing cases in adults roentgen treatment may be effective to a certain degree. In the rapidly progressing type in children it is probably useless to use roentgen and torture the little suffering patients with transports to the roentgen department. If there are painless periods a roentgen treatment may be tried.

SUMMARY

Myeloma in children is very rare and only a few cases are described in the literature of the world. The author gives a description of a myeloma in a 9 year-old boy. In addition to the very limited foci in the leg, there was a diffuse decalcification of all the vertebrae which were all shrunken to thin biconcave discs. (Platyspondylia generalisata myelomatosa).

ZUSAMMENFASSUNG

Myelome bei Kindern sind grosse Seltenheiten, und in der Weltliteratur sind nur einige wenige Fälle beschrieben. Verf berichtet über ein Myelom bei einem 9jährigen Knaben. Ausser den typischen, gut abgegrenzten Herden in den Knochen, lag ein diffuser Kalkschwund in sämtlichen Wirbeln vor, die zu dünnen, bikonkaven Platten zusammengesunken waren (Platyspondulia generalisata myelomatosa).

RÉSUMÉ

Le myélome est une affection extrêmement rare chez les enfants: la littérature mondiale n'en décrit que quelques cas. L'auteur présente un cas de myélome chez un garçon de neuf ans. Outre les foyers typiques nettement circonscrits dans les os, toutes les vertèbres présentaient une décalcification diffuse et étaient réduites à de minces plaques biconcaves (Platyspondylie myélomateuse généralisée).

FROM THE MEDICAL SERVICE OF THE COUNTY HOSPITAL, MARIBO, DENMARK
(CHIEF: POUL VOGT-MØLLER, M. D.)

A CASE OF TIBIA RECURVATA[1]

by

Karen Lübschitz

Consulting Roentgenologist

Tibia recurvata is a rather uncommon deformity; the following communication of a case may therefore perhaps be of interest.

The patient (case record no. 608/44) was a farmer, 53 years old, admitted to the Maribo Hospital 6th June to 7th July, 1944, for encephalomalacia, hypertension and arteriosclerosis. As he complained, among other things, of difficulty of walking and pain in the left leg, a roentgen examination was made of his knee- and hip joints. Anterior view of the left knee (Fig. 1) showed the articular interspace apparently obliterated and the patella lower than on the right side. In the lateral view (Fig. 2) it was seen, however, that the interspace was fully preserved, and that the curious frontal view was due to a deformity of the upper part of the tibia, whose articular surface was placed proximo-anteriorly instead of, as normally, proximo-posteriorly. Whereas there on the right side, where the conditions were normal, was an angle of 173°, opening backwards, in the upper part of the tibial diaphysis, about opposite the tuberosity of the tibia, there was on the left side an angle of 160° opening forwards, and here the tuberosity seemed to be lacking, or at least there was only a slight, shallow indentation, corresponding to the insertion of the inferior patellar ligament. The fibula showed a slight convexity from before backwards, parallel to the arc described by the tibia. Otherwise the structure of the bone was normal, and there were no signs of osseous processes or sequelæ of such, beyond some slignt indications of deforming arthrosis in the knee joint, similar to what was the case also in the right knee. The right leg showed the sequelæ of a fracture both of the tibia and the fibula. In both extremities there was arteriosclerosis of the arteries of the poples and the leg. *Roentgenologic diagnosis:* Left tibia recurvata, deforming arthrosis of both knees, arteriosclerosis; sequelæ of fracture of right leg. Roentgen examination of the hip joints showed slight signs of deforming arthrosis in both sides, otherwise nothing abnormal.

Externally (Fig. 3) the deformity showed itself in a marked prominence of the patella and the condyles of the femur, which might suggest subluxation of the knee; but also by external examination it was possible to realise that the seat of the deformity was below the knee joint itself. Corresponding with the roentgenologic findings there was no deformity of the right leg.

With regard to the anamnesis, the patient stated that in 1930, when he was 39 years old, he had sustained an injury to his right leg, which was found to be fractured. The

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physician fetched in called his attention to the deformity of his left leg, which he had not noticed before. It had never been subject to any trauma, and there had never been any signs of it being affected. Of illnesses, he had only had measles and scarlatina as a child, and in connection with these there did not seem to have been any symptoms from the lower extremities. During his stay in the Maribo Hospital he was found to be suffering from hypertension, and there were signs of arteriosclerosis of the heart and brain. The Wassermann reaction was negative.

The deformity here described is rather uncommon. In 1937, SCHUELE reported from Vienna a case in which there in a woman, 57 years old, incidentally was found a roentgenologic picture precisely similar to the one in our patient, and an external deformity of exactly the same appearance as in our case, except that in SCHUELE's patient the affection was bilateral. The condition, which had always been present, had never caused her any trouble or discomfort. SCHUELE thinks that it is a matter of congenital defect of the tuberosity of the tibia, and believes that his case is the first one reported in medical literature.

Several cases of similar deformities had been reported before, though. HUMPHRY, in 1862, seems to have been the first who described the condition, which he calls »back-knee». His paper has not been available to me, but according to a reference to it in a society report from 1889 there can be no doubt that it was a case of tibia recurvata. He explains the deformity as due to defective growth, presumably with rickets as the causative factor.

In 1876, SONNENBURG described a case of tibia recurvata developed as the result of a gonitis which ended in ankylosis. He explains the recurvation as a sort of correction to the flexed position in which the knee joint was fixed. JALAGUIER described in 1890 a case in a boy with ankylosis in the knee due to luetic gonitis. He supposes that the ossification has become arrested earlier in the anterior part of the upper epiphyseal line of the tibia than in the posterior, owing to some injury sustained by the cells of the anterior part in the course of the bandage treatment with the knee in extended position, because the static pressure there was strongest anteriorly. In the same year, KIRMISSON published 2 cases in which the deformity developed in connection with arthritis in the knee joint, and another, in which it occurred without any preceding affection whatever. This last case he explains as a *rachitisme local*, since otherwise there were no signs of rickets. In 1896, STAFFEL described a precisely similar case, in which there was no affection, either local or generalised, in the anamnesis to account for the existence of the deformity.

PATEL & CAVAILLON, in 1904, are the first who mention tibia recurvata in connection with ankylosis of the hip joint following coxitis, but otherwise PELTESOHN is the one who has dealt most thoroughly with the subject, in a number of studies from 1908 to 1933.

Fig. 1 a. Fig. 1 b. Fig. 2 a. Fig. 2 b.

Fig. 1. a) The right, normal knee seen from the front. b) The left knee seen from the front; notice the low situated patella and the apparent narrowing of the articular interspace.

Fig. 2. a) The right, normal leg seen from the side. b) The left leg seen from the side; notice the inclination of the articular surface of the tibia and the apparent absence of the tuberosity of the tibia.

He divides the cases into the following 4 groups according to the etiology. Tibia recurvata may occur:

1) as a constitutional anomaly;
2) as result of general softening of the bones, for instance in rickets;
3) as result of a local softness of the bone,
   a) from some unknown cause during the age of growth,
   b) following a lesion of the epiphyseal cartilage,
   c) in peripheral (perhaps also in spastic) pareses of the extremities in conjunction with flexion contracture in the knee and hip;
4) as a static, dynamic deformity
   a) in conjunction with a simultaneous ankylosis of the knee joint, of inflammatory character,
   b) in conjunction with a coxitic flexion contracture on the same side.

Fig. 3 a.

Fig. 3 b.

Fig. 4.

Fig. 3. a) The right, normal lower extremity seen from the medial side. b) The left lower extremity seen from the medial side; the recurvation is below the knee.
Fig. 4. The right knee from the lateral side. Notice that the axis through the tibia is a straight line, and the concavity in the place of the tuberosity.

As regards the primary tibia recurvata, of which he reports a case observed by himself, he believes that it is due to displacement in the epiphyseal line. That the flexion is seen to lie lower than the latter he explains by the point of flexion becoming displaced more distally during the process of growth, which occurs chiefly corresponding to the upper epiphyseal line of the tibia. Of the cases of tibia recurvata that occur in connection with ankylosis of the knee joint he thinks that it may just as likely be a question of a local collapse of the bone as of an injury to the epiphysis. With regard to tibia recurvata in patients with coxitis he points out that the deformity is rare in proportion to the great number of these. Its development in such cases is due to the hip joint becoming ankylosed in a position of flexion so extreme that the increase of lordosis alone is insufficient to compensate it. That the process results in tibia recurvata and not in genu recurvatum is because there is flexion-contracture in the knee at the same time, and the deformation therefore occurs corresponding to the points of insertion of the flexor muscles of the thigh. In his first paper, in 1908, PELTESOHN discussed the possibility of a tuberculous process at the point of flexion in the tibia, but in his later writings it seems as if he has abandoned this hypothesis. He does not directly say so, but the fact that he no longer mentions it is an indication of this being the case. BAUER, who in 1933 reports a case of tibia recurvata in

connection with coxitis, goes in, however, for the supposition of tuberculous affection in a milder form — a »*tuberculose inflammatoire*» — in the epiphyseal area, as cause of the bend in the tibia.

PELTESOHN is no doubt right in saying that tibia recurvata is a rare deformity. More particularly is this true as regards the primary form, of which only 6 cases have been reported hitherto, namely HUMPHRY two, KIRMISSON, STAFFEL, PELTESOHN and SCHUELE one each; to which now comes as the seventh the case here reported from Maribo.

In the cases where there is no knowledge of any existing pathologic condition, or any history of trauma, to account for the deformity, the cause of its occurrence is more or less conjectural. In my case, we have seen that the patient could not say at what time of life it had developed; in SCHUELTE's case the patient thought it had been present since early childhood; — in both it was found incidentally. With regard to HUMPHRY's case I have not sufficient information, but both KIRMISSON's, STAFFEL's and PELTESOHN's patients were young men — aged respectively 16, 16 and 23 years — who sought the physician's advice because they had seen the condition developing for some years past. PELTESOHN's patient complained of some weakness in the extremity involved, but none of the others had experienced any trouble or discomfort from the deformity, nor could there in these cases be demonstrated any preceding trauma or affection that might be thought to be a causative factor.

Thus, it can hardly be supposed that an infectious or traumatic affection of the epiphyseal cartilage was the cause of the recurvation of the tibia in these cases, nor is there anything to justify the supposition of rickets as etiologic factor. If we follow PELTESOHN's list of possible causes, there remains, as regards the primary occurrence of tibia recurvata, only the supposition of a constitutional anomaly or of development as result of a local mollities of the bone, from some unknown cause, during the age of growth. Whether it is a question of constitutional anomaly is difficult to determine, but so far no hereditary factor has been ascertained. To me it seems a more likely supposition that the deformity occurs as the result of a temporary, local softening of the bone during adolescence, presumably about the age of puberty. We know that disturbances of the ossification occur at this period in other parts of the organism; especially must we here think of the changes which result in epiphyseolysis in the femur and the development of coxa vara, the etiology of which, according to WALDENSTRÖM, is the same — namely a temporary, local deficiency of bone formation between the epiphyseal cartilage and the metaphysis, probably due to endocrinous disturbance of a temporary character. Though such disturbances of the ossification no doubt, owing to certain static-dynamic conditions, most often occur in the upper end of the femur, it seems to me likely that they may occur in the tibia, as well. Besides, we know that

disturbances of growth occur in the proximal epiphyseal line of the tibia, resulting in other deformities (crus varum, genu varum); most probably the etiology in these cases is the same.

The question whether the tuberosity of the tibia has been present with its nuclei in these cases of primary tibia recurvata can hardly be answered. SCHUELE's theory of their absence being the cause of the development of the deformity may seem plausible, but it seems to me that it in this connection is enlightening that in some of the reported cases of coxitic tibia recurvata, in which the deformity was demonstrated in children, the nucleus of the tuberosity could be seen, at least partly; thus in one of PELTESOHN's patients, a girl 12 years old, where the proximal, snout-shaped part of it could be seen in the roentgenogram.

As regards the secondary forms of tibia recurvata, some experimental observations made by NAGURA are probably of some interest. In experiments on animals he found that minor operations on one femur of an animal, made with the view of provoking changes corresponding to those in Calvé-Perthes's disease, resulted in changes also in the other. Pathoanatomic examination of the sound femur some time after the operation, and after this leg, owing to the affection in the other, had had to sustain an extra part of the animal's weight, showed interruption of the continuity of the osseous tissue, with incipient reparatory changes. It is not unreasonable to think that the development of the deformity in the cases where it occurs in connection with coxitis or with ankylosis of the knee joint may be due to similar changes.

I may also briefly mention a case, a man (out-patient) 42 years old, of whose hips and knees I made a roentgen examination. He had an affection of the hip after a trauma sustained when he was about fourteen years old. In this case it was probably a matter of epiphysis detachment in the proximal end of the femur, resulting in coxa vara (and, later, arthritis deformans). The roentgenogram of the knee on the same side (Fig. 4) showed that the upper articular surface of the tibia was not, as normally, slightly inclined backwards, but made a right angle with the axis through the shaft of the bone. The tuberosity, or at least its lower part, which develops from a separate nucleus, seemed to be absent; in its place there was a shallow concavity in the bone. In other respects the latter was normal. In this case there cannot be said to be any actual tibia recurvata, because there was no recurvation of the bone; but the vertical axis of the tibia without the normal angular projection forwards at the level of the tuberosity, and the inclination of the upper articular surface as well as the absence of the tuberosity, make one think of a not fully developed tibia recurvata; and considering the affection in the hip there can in fact hardly be any doubt that the mechanical cause of the origin of the condition was the same as in coxitic tibia recurvata.

As tibia recurvata practically never gives rise to any symptoms, there cannot be question of any therapy; and like many other deformities the condition is therefore rather of interest theoretically and on account of its seldomness.

SUMMARY

The author describes a case of primary tibia recurvata in a man 53 years old — the seventh case reported in medical literature. The manner of its origin is unknown, but the author believes that it was due to disturbances to the ossification owing to endocrinous changes of a temporary character during the age of puberty, similar to those which, according to WALDENSTRÖM, are accountable for the development of coxa vara. Also a little pronounced case of secondary tibia recurvata is mentioned.

ZUSAMMENFASSUNG

Verf. beschreibt einen Fall von primärer Tibia recurvata bei einem 53 Jahre alten Manne — der 7. im medizinischen Schrifttum wiedergegebene Fall. Die Entstehungsweise ist unbekannt, doch meint Verf., dass das Leiden durch Verknöcherungsstörungen bedingt war, die durch zeitweilige, endokrine Veränderungen im Pubertätsalter hervorgerufen waren, welche an diejenige erinnern, die nach WALDENSTRÖM für die Entstehung einer Coxa vara verantwortlich sind. Ferner wird ein wenig ausgesprochener Fall von sekundärer Tibia recurvata erwähnt.

RÉSUMÉ

L'auteur décrit un cas d'incurvation du tibia à concavité postérieure chez un homme de 53 ans, le septième rapporté dans la littérature médicale. La pathogénèse en est inconnue, mais l'auteur croit que dans son cas, la déformation est due à des troubles de l'ossification provoqués par des désordres endocrines de caractère temporaire durant la puberté, semblables à ceux qui, suivant WALDENSTRÖM, interviennent dans la pathogénèse de la coxa vara. L'auteur mentionne aussi un cas de légère incurvation secondaire du tibia.

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FROM THE INSTITUTE OF RADIOPHYSICS; KING GUSTAF V'S JUBILEE CLINIC
(CHIEF: PROFESSOR R. M. SIEVERT)

A STUDY OF THE DISTRIBUTION OF RADIOACTIVE PHOSPHORUS IN THREE CASES OF CANCER[1]

by

Arne Forssberg

Radioactive isotopes, especially radiophosphorus, ^{32}P, have been frequently used in biology and medicine for the last ten years, originally as an aid in the study of metabolism. As a therapeutic agent it has been tried in various U. S. A. Clinics, chiefly in cases of leukemia. The experiences of some years' work has been summed up by KENNEY (1) of the Memorial Hospital, and by ERF (2) and ERF and LAWRENCE (3) on behalf of the Californian school. KENNEY has come to the conclusion that although the administration of ^{32}P might be a useful therapeutic agent in cases of chronic lymphatic leukemia and lymphosarcoma, it has no improving effect in cases of acute leukemia. As a rule the single doses varied from some tenth of a mC up to 5 mC. The total optimal dose should according to KENNEY be about 500 μC per kg. of body weight. The treatment was usually protracted over a period of several weeks.

The therapy with radioactive isotopes is based on the distribution of the radioactive agent in the body, which is a metabolic process. Hence, the therapy would be favoured when the neoplastic cells store considerably more radioactivity than the normal cells. Judging by the experience of KENNEY this condition is fulfilled in instances where good clinical results are reported.

Last year radioactive phosphorus was administered at Radiumhemmet in a few cases of cancer. In three instances autopsies made analyses on radioactive phosphorus possible. The results will be given below, although the material up to now is too scanty to permit any detailed discussion. The radioactive phosphorus, which emits β-radiation with a half-period of 14.3 days, was given intravenously in the form of Na_2HPO_4. The amount of nonradioactive phosphorus injected at the same time varied from 80 to 210 mg.

[1] Submitted for publication, June 30, 1945.

The physical details have been described elsewhere (4); in short weighed portions of the organs were burned and the radioactivity was then measured with a Geiger-Müller device. The results are given as μC ^{32}P per gram of wet weight. The values were corrected for decay back to the date of death. MARINELLI's calculations (5) give some information on the doses delivered by a given ^{32}P quantity in the tissue: Assuming a concentration of 1 μC ^{32}P per gr. of tissue, this quantity would equal:

a) an actual dose of 43r/24 hours.
b) a total dose of 880 r., delivered throughout the period of radioactive decay (several months).

One difficulty involved in the application of these calculations is that the concentration of radioactive phosphorus in a given tissue will change from one time to another. Analyses made on a single occasion, as in this case therefore only give the actual doses. To get some conception of the total doses delivered, the metabolistic changes of the radioactive phosphorus after the injection, the principal features of which are known, must also be considered. Estimated on this basis, the doses administered in the following cases were probably too weak to be of any great therapeutical value. Consequently the main interest lies in a study of the distribution of radiophosphorus to the organs. In the following the three cases are analysed and the corresponding pathological diagnoses given. For the latter the author is indebted to the Radiumhemmet Pathological Institute.

Case 1. Male, 71 years. *Hypernephroma renis et metastases ossium et cutis.* ^{32}P doses: 3 mC 13/12; 5 mC 23/12 1943. Died 31/12 1943.

Pathological diagnosis: *Kidney:* Tumour with polymeric, long spool-shaped cells; nuclei rich in chromatine. The structure of the tumour was hypernephroma-like. *Metastasis at rib 7.* The structure was on the whole of the same type as in the kidney.

Measurements are given in Table I.

Table I.

Radioactivity expressed in 10^{-3} μC pr gram of wet weight.

Whole Blood	Kidney		Spleen	Liver	Lung	Brain	Bone, femur	Bone-marrow	Tumour at rib 7.
	»normal»	tumour							
25.1	33.5	52.4	39.0	91.0	41.0	6.7	1.5	13.1	71.4

Case 2. Female, 37 years. *Ca. mammae dx. et metastases ossium.* Metastases of liver, spleen, ovarium, and the lymphnodes. ^{32}P was given three times: 5 mC 13/1; 3.8 mC 5/2; 2.4 mC 25/2. Died 26/3 1944.

Pathological diagnosis: *Liver:* Metastases very rich in connective tissue, sparsely mixed with cancer cells of the ovarial type (see below). *Spleen:* Metastases of the same tumour-type, but more carcinomatic in structure. *Ovaries:* The cancer was relatively little differentiated, with small solide epithelial cellstrings. *Vertebral column:* Bone metastases, rich in vegetations of a more smallcellular type.

The analyses are summarized in Table II.

Table II.

Radioactivity expressed in 10^{-3} μC pr gram of wet weight.

Whole Blood	Kidney	Spleen		Liver		Lung	Pancreas	Ovarial tumour	Omentum	Muscle	Skin (abdominal)		Ribs	Femur	Vertebrae		Bone-marrow
		»normal»	tumour	»normal»	tumour						»normal»	tumour			tumour	tumour, strongly necrotic	
7.7	28.3	33.2	43.2	39.3	31.4	15.0	29.2	29.6	6.0	18.5	18.0	34.6	84.7	21.7	324	183	30.0

Case 3. Female, 47 years. *Ca. mammae.* Metastases in vertebral column, ribs, skull, liver, and lungs. ^{32}P was given twice: 2.8 mC 21/4; 3 mC 5/5. Died 10/5 1944.

Pathological diagnosis: *Liver:* Metastases of adenomatous cancer. *Lungs*: In the left lung a thick, fibrous capsule, 1 cm. in diameter, surrounding a necrotic tissue of undecided origin; dead tissue, with poor nutrition. *Mammae:* Cancer growths of the same type as in the ribs occurred in the connective and fatty tissues. *Skull:* Proliferating cancer tissue. *Vertebral column:* Cancer metastases in sclerotic connective tissue. *Ribs:* Metastases with small, dark cancer cells.

The corresponding analyses are summarized in Table III.

Table III.

Radioactivity expressed in 10^{-3} μC pr gram of wet weight.

Whole Blood	Kidney		Spleen	Liver		Lung		Mammae		Muscle	Ribs			Skull		Vertebrae	
	»normal»	tumour		»normal»	tumour	»normal»	tumour	»normal»	tumour		»normal»	tumour	tumour, partly mixed with normal bone tissue	»normal»	tumour	bone, infiltered with cancer	tumour, necrotic
51.3	276	264	278	381	318	138	63.4	11.5	44.0	76.3	17.8	288	167	107	330	231	218

Discussion of results: As has already been pointed out, the experimental material is too scanty to allow any closer discussion of the results. Only a few points will be discussed.

If the tumour is situated in the liver, kidney, or spleen, *i. e.* in organs of high metabolic rate, the neoplastic tissues seem to store the same

average amount of ^{32}P as the corresponding »normal» tissue. The ratio: $\frac{^{32}P \text{ in tumour}}{^{32}P \text{ in normal organ}}$ accordingly does not differ appreciably from unit except possibly in Case I, kidney. If the tumour is situated in other organs whose metabolic rate is lower, however, the quotient of neoplastic to normal tissue may be somewhat higher; *e. g.* in the skin (Table II) or the mammae (Table III). The lungvalues of Table III, where the tumour holds only half as much ^{32}P as the corresponding normal lung tissue, offer an apparent exception. The histological examination revealed, however, that the tumour was completely necrotic with bad nutrition. Hence, the poor assimilation of ^{32}P in this case may be clearly understood.

This agrees with the results of JONES, CHAIKOFF and LAWRENCE (6), who worked with lymphoma, lymphosarcoma and mammary carcinoma on mice, as well as with an investigation of the assimilation of ^{32}P by rabbits grafted with Pearce-Brown carcinoma (5). These investigations prove that the radiophosphorus contents of the neoplastic tissues generally not exceed those of the liver, kidney and spleen.

The concentration of radiophosphorus in the bones and their metastases attracts special interest in the above cases. It is known that finally about 90 % of an administered dose of ^{32}P is found in the bones. Judging from analyses made here, the concentration of ^{32}P in bone-metastases may even exceed that in fresh bones. Then in certain cases, the relative distribution of radiophosphorus between metastatic bone and normal bone seems to be rather favourable. In Case 2, where the intervals between the first and the last injections and death were 70 and 30 days respectively, the distribution of radiophosphorus showed accentuated accumulation in the metastases of the vertebrae. Analysis of the corresponding normal parts were unfortunately not performed in this case. The values are, however, considerably higher than those of the normal ribs and the femur from the same case. In Case 3, too, the concentration in the bone-metastases is rather high; here the actual values for the liver etc. equal or even exceed those of the bones and the bone-metastases owing to the fact that a dose of ^{32}P was given to the patient only a few days before death.

Hence, the chances of improving bone-metastases would seem at least conceivable. The question is whether it would be possible, without danger to the organism, to »charge» them to a sufficient high degree of radioactivity by successive injections without injuring the radiosensitive bloodforming elements during the treatment. Further experience of this is required.

SUMMARY

The distribution of radioactive phosphorus (^{32}P) given intravenously in three cases of cancer, has been analysed. The analyses showed that metastases in the kidneys, the liver or the spleen absorbed about as much ^{32}P as the corresponding »normal» tissues. Metastases in certain other tissues (skin, mammae) absorbed noticeably more ^{32}P than the normal organs, but not more than the liver etc. The analyses were rather favourable in some cases of bone-metastases, and the possibility of a therapy in such cases may be worth while a further investigation.

ZUSAMMENFASSUNG

Es wird berichtet über einige Analysen von radioaktivem Phosphor (^{32}P) in drei Cancerfällen gegeben. Die Analysen zeigten, dass Metastasen in Leber, Niere und Milz etwa die gleichen Mengen ^{32}P aufnahmen als die entsprechenden gesunden Teile. Metastasen in der Haut und der Mammae erwiesen dagegen etwas grössere Werte als die entsprechenden normalen Gewebe, doch nicht grösser als Leber etc. Ziemlich günstige Ergebnisse wurden für Metastasen in Knochengewebe gefunden. Es erscheint nicht ausgeschlossen, dass in solchen Fällen eine erfolgreiche Therapie möglich wäre.

RÉSUMÉ

L'auteur a procédé à des analyses de phosphore radio-actif (^{32}P), administré par voie intra-veineuse dans trois cas de cancer. Elles ont démontré que des métastases formées dans le foie, le rein et la rate absorbaient presque autant de ^{32}P que les organes frais correspondants. Les métastases dans la peau et le sein présentaient un plus haut degré d'activité que les organes normaux correspondants, mais pas supérieur à celui des organes susnommés. If a obtenu des résultats assez favorables dans les analyses de métastases osseuses et la possibilité d'une thérapeutique dans ces cas paraît devoir être étudiée plus à fond.

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FROM THE BISPEBJERG HOSPITAL, DEPARTMENT A (CHIEF: JENS FOGED, M. D.), THE ROENTGEN DEPARTMENT (CHIEF: CHR. I. BAASTRUP), AND THE ANATOMICAL INSTITUTE OF THE UNIVERSITY OF COPENHAGEN (CHIEF: PROFESSOR HARALD OKKELS, M. D.)

ON THE NORMAL ARTHROGRAM OF THE MANDIBULAR JOINT[1]

by

H. H. Jacobsen

Roentgen arthrography of the mandibular joint, was attempted some years ago at the Bispebjerg Hospital. During the past years this method of examination has been used systematically at the Danish College of Dentistry, and also for a time, at the Bispebjerg Hospital. The pictures, which are taken with the central ray directed from above and frontally, making an angle of 65 degrees with the median plane of the head, show a distinctly drawn shadow in each of the spaces between the discus and the articulating parts of the bone, and furthermore, a rather less intense shadow, which covers the capitulum and a larger or smaller part of the collum mandibulae. It is obvious that the lower cavity of the joint is capable of giving the mantel-like shadow described, it has, however, been questioned whether a similar shadow could be due to the upper cavity.

In order to answer the question, I have made the following experiments:

1) On a preparation from a corps (man aged 50 years) I injected a mixture of contrast substance and indian ink, into the upper joint cavity of the right mandibular joint. The picture (Fig. 1) showed the above mentioned mantel-like shadow. It was simple by a subsequent dissection, to show that the indian ink only was to be found in the upper cavity.

2) On another preparation from a corps (man aged 79 years) I injected plaster of Paris to which was added lead-chloride. The result was the same as previously (Fig. 2). A picture taken with the central ray having a sagittal direction (Fig. 3), showed that the upper cavity when

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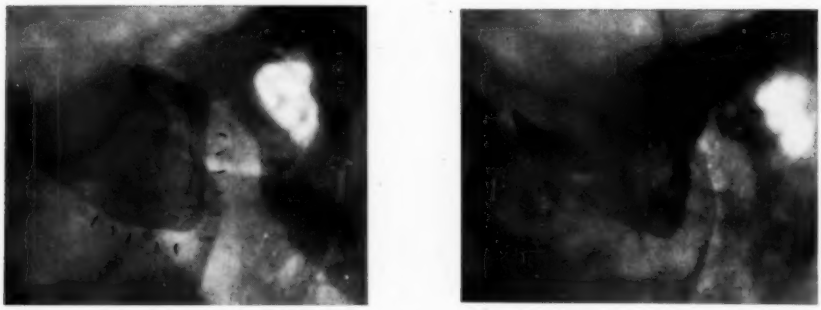

Fig. 1. (Preparation no. I). The upper right cavity. In the first picture, the outline of the mantel can just be made out. In the second picture, where the filling is more plentiful, the mantel is more clearly marked.

(For guidance, the meatus acusticus externus is behind the mandibular joint, in all the lateral views.)

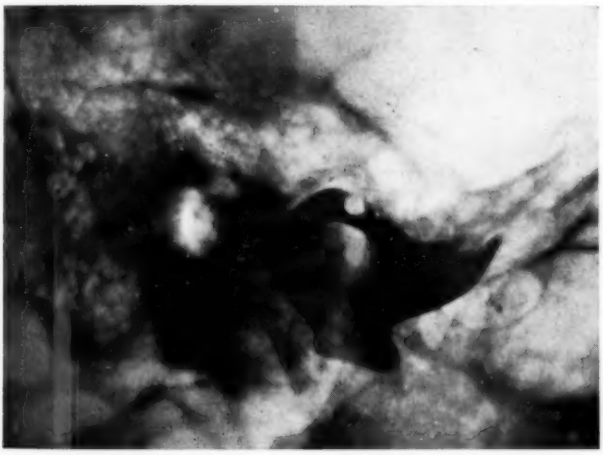

Fig. 2. (Preparation no. II). The upper left cavity, filled with plaster of Paris, to which lead-chloride is added. The small defect in the shadow, in the upper part of the picture, marks the position of the needle.

filled, reaches farther medially than laterally, in proportion to the capitulum. This was confirmed by the dissection of the mandibular joint containing the solidified plaster of Paris. As the diagram (Fig. 4) shows, it is the medial part of the upper cavity which is projected down on to the collum.

3) A patient (woman aged 26 years, Bispebjerg Hospital, dep. A.

Fig. 3. (Preparation no. II). The upper left cavity. Antero-posterior view. It is seen that the plaster of Paris hangs farther out over the capitulum, medially than laterally.

Roentgen examination 310/45) was examined for an arthrosis temporomandbularis. Although several attempts were made, none were successful in reaching any lower cavity by arthrography; a good picture of the upper cavity was obtained however, which showed a distinct shadow across the collum (Fig. 5). When this patient was operated on, nothing abnormal excepting a fragile adherence in the upper cavity was found, whereas, although a lower cavity was sought, none was found; the discus had grown firmly on to the capitulum.

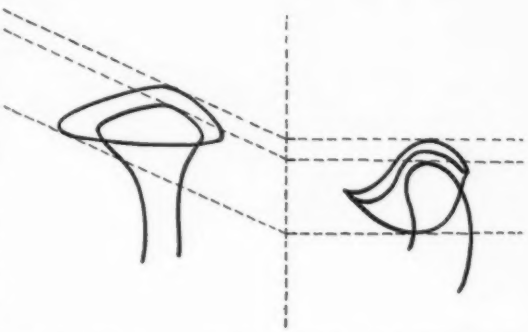

Fig. 4. Lines are drawn through the bottom of the fossa mandibularis, the top of the capitulum and the medial part of the upper joint cavity.

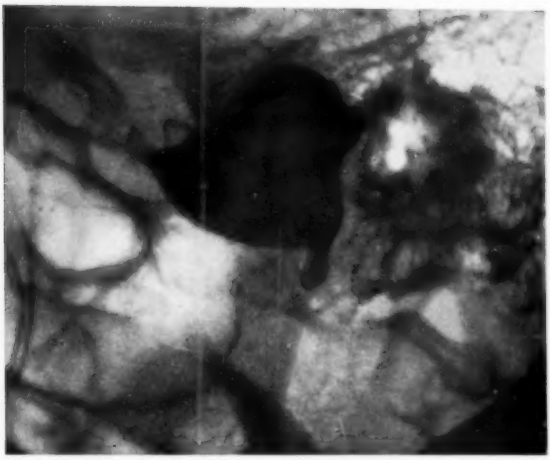

Fig. 5. (310/45). The upper right cavity. At the operation no lower cavity was found, in this patient.

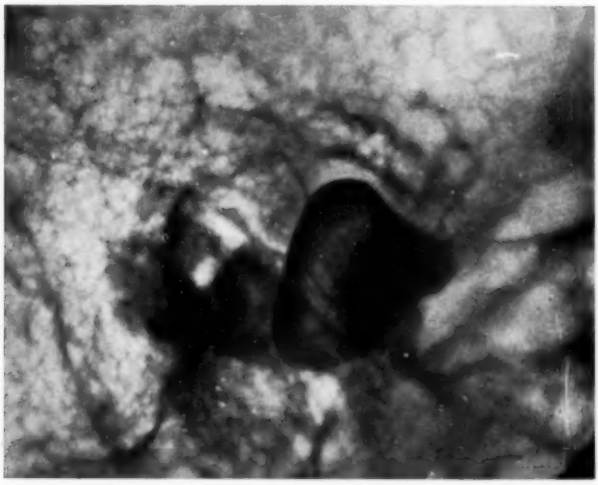

Fig. 6. (1619/45). The lower left cavity. Is shown for the sake of comparison. See the text.

For comparison I have included a picture of the lower cavity, which I consider normal (Fig. 6, man aged 16 years, Bispebjerg Hospital, dep. A. Roentgen examination 1619/45).

The essential differences in the pictures of the two cavities are then (Fig. 7):

1) The amount of contrast is greater in the upper cavity than in the lower.

2) The pictures of the upper cavity, show a space between the dense part of the contrast shadow and the capitulum; in the pictures of the lower cavity the space is situated between the temporal bone and the contrast shadow. The space represents the discus.

3) In the pictures of the upper cavity the greater part of the contrast substance is above the capitulum, often it is equally distributed in the front and at the back (when the mouth is opened, the greater part of the contrast is collected behind and above in the large synovial fold at the back, above the discus, clinging closely to the fossa mandibularis); in the lower cavity the greater part of the contrast passes down along the back of the capitulum.

Fig. 7. A comparison of the pictures of the two cavities. See the text.

4) In the pictures of the upper cavity, the contrast reaches farther forwards than in the pictures of the lower cavity.

SUMMARY

In the arthrograms of the mandibular joint, a mantel-like shadow is seen across the capitulum. It is obvious that the lower joint cavity will cast a shadow of this type. It is shown that a similar but in some respects different shadow, may derive from the upper joint cavity.

ZUSAMMENFASSUNG

In dem Arthrogramm des Mandibulargelenks ist ein das Capitulum überquerender, mantelförmiger Schatten zu sehen. Offenbar wird die untere Gelenkhöle einen Schatten dieser Art geben. Es wird nachgewiesen, dass ein ähnlicher, in gewissen Hinsichten jedoch abweichender Schatten von der oberen Gelenkhöle herrühren kann.

RÉSUMÉ

Dans les images d'arthrographie mandibulaire on voit un ombre de forme de cape à travers du capitule. Il est évident que la cavité de l'articulation inférieure donne un ombre de ce type. L'auteur démontre que la cavité de l'articulation supérieure peut produire un ombre similaire mais à certains points différent.

LITERATURE

FLEMMING NØRGAARD: Acta Radiologica, XXV, fasc. 5—6, p. 679, 1944.

Notice:

A David Anderson-Berry Silver-gilt Medal, together with a sum of money amounting to about £ 100, will be awarded in 1947 by the Royal Society of Edinburgh to the person, who, in the opinion of the Council, has recently produced the best work on the therapeutical effect of X-rays on human diseases.

Applications for this price are invited. They may be based on both published and unpublished work and should be accompanied by copies of relevant papers.

Applications must be in the hands of the General Secretary, Royal Society of Edinburgh, 22 George Street, Edinburgh 2, by December 1, 1946.